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Original Research Article.

A Comparative Study of Effect of Exercises on Respiratory Parameters Between Normal, Overweight and Obese Young Adults

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ABSTRACT

Background: Obesity is defined by WHO as "excessive body fat that cause damage to the individual's health. Alterations in the pulmonary system linked to obesity include abnormalities in ventilatory mechanics and muscle function, ventilatory control, pulmonary gas exchange. The purpose of this study is to evaluate the respiratory response to exercise in normal weight and overweight young adults.

Methods: The present work was conducted on total 210 young adults of MMU, Mullana, Ambala, (Haryana) of which 70 forming the normal weight group, 70 forming overweight group and 70 forming obese group in MMU, Mullana, Ambala (Haryana), for assessing the respiratory parameters in response to exercise.

Results: In response to exercise a) RR was significantly ($p<0.001$) increased in all three groups i.e. normal weight, overweight, and obese subjects, b) FVC was very highly significantly ($p<0.001$) reduced in normal weight and it was also reduced in both overweight and obese groups although it was not significant ($p>0.05$), c) FEV1 was reduced in girls as compared to boys but the reduction was found to be very highly significant in overweight and significant in obese and not significant ($p>0.05$) in normal weight, d) FEV1/FVC was reduced in normal weight but the change was not significant in overweight and obese ($p>0.05$). The ratio was reduced in normal weight girls, although was not significant ($p>0.05$), and it was increased in overweight and obese girls which was significant ($p<0.05$) in obese but not in overweight girls, e) PEFR is reduced in all the three groups and the reduction was significant ($p<0.05$) in normal weight but not significant ($p>0.05$) in overweight and obese, f) The mean ERV was reduced very highly significantly ($p<0.001$) in normal weight, significantly ($p<0.05$) in obese and was not significant ($p>0.05$) in overweight, g) MVV was reduced but not significantly ($p>0.05$) in all the three groups. No significant change was found in mean MVV between boys and girls of all groups.

Conclusion: There is an adverse effect of obesity and lack of exercise on respiratory parameters. A significant reduction in lung functions like FVC, ERV, MVV was seen with increase in BMI.

Keywords: Exercises, Respiratory Parameters, BMI, Obesity.

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INTRODUCTION

Obesity is defined by WHO as "excessive body fat that cause damage to the individual's health".[1] Obesity in adults is also defined by WHO as having a body mass index (BMI) that is greater than or equal to 30kg/m².[2] According to WHO the number of overweight and obese people worldwide will increase to 1.5 billion by 2015 if current trends continue. Clearly, overweight and obesity place a large public health burden on society.[3]

Obesity has now become an important health problem in developing countries particularly in India.[2] The consequences of industrialization and urbanization, which lead to decrease in physical activity, together with substantial dietary changes and overall pattern of life style, promote weight gain. Although all risks associated with increasing weight are aggravated in persons with body mass index >40 kg/m², a body mass index between 25 and 30 kg/m² should be viewed as medically significant and worthy of therapeutic intervention especially in the presence of risk factors. The influence of increased percentage of body fat (body fat >35%) and central obesity on blood pressure and glucose intolerance has been well documented.[4,5]

Alterations in the pulmonary system linked to obesity include abnormalities in ventilatory mechanics and muscle function, ventilatory control, pulmonary gas exchange. Signs and symptoms of these problems tend to worsen when a patient who is obese is supine.[6] Complete pulmonary function testing (measuring spirometry, lung volumes, and diffusion) often shows a restrictive pattern with decreased expiratory reserve volume (ERV), and functional residual capacity (FRC). Total lung capacity (TLC) and residual volume (RV) are maintained except in cases of extreme obesity, where TLC and RV decrease as weight increases. Most patients maintain a normal forced expiratory volume in 1 second/ forced vital capacity ratio (FEV1/FVC) in the absence of other lung disease. Pulmonary gas exchange (indirectly assessed by measuring the diffusion in the lung of carbon monoxide) may be normal or increased. Obesity impairs ventilatory function in several ways. As BMI rises, typically all lung volumes are reduced while expiratory airflow remains normal. Mechanical effects of obesity on the diaphragm and chest wall lead to impaired diaphragmatic excursion and reduced thoracic compliance.[7-10]

Increasing weight can lead to various deleterious effect to respiratory function such as alterations in respiratory mechanics, decrease in respiratory muscle strength and endurance, decrease in pulmonary gas exchange, lower control of breathing and limitations in pulmonary function tests and exercise capacity.[4-6] These changes in lung function are caused by extra adipose tissue in the chest wall and abdominal cavity, compressing the thoracic cage, diaphragm, and lungs. The consequences are a decrease in diaphragm displacement, a decrease in lung and chest wall compliance, and an increase in elastic recoil, resulting in a decrease in lung volumes and an overload of inspiratory muscles.[7] Spiro metric variables, such as forced expiratory volume in 1sec (FEV_1) and forced vital capacity (FVC), tend to decrease with increasing BMI. However, the effect is small, and both FEV_1 and FVC are usually within the normal range in healthy, obese adults and children. The FEV_1-to FVC ratio is usually well preserved or increased even in morbid obesity indicating that both FEV_1 and FVC are affected to the same extent.[8]

Overweight adults uses a greater amount of O_2 to accomplish an equal external workload when compared to non-obese subjects.[9] VO_2 max reflects the amount of oxygen utilized by working muscle during maximal exercise.[10-12] VO_2 max (Maximum O_2 uptake) is the measure of functional limit of the cardio respiratory system and the single most valid index of maximal exercise capacity.[13]

The purpose of this study is to evaluate the respiratory response to exercise in normal weight and overweight young adults.

MATERIALS AND METHODS

After obtaining Institutional Ethical Committee Approval and Informed and written consent from all the subjects the study was conducted in the Department of Physiology, Maharishi Markandeshwar Institute of Medical Sciences and Research, Mullana (Ambala). The students of Maharishi Markandeshwar University (MMU), Mullana, between the age groups of 18 to 30 years were included in the study population.

The selected subjects, which include male and female students of MMU, were divided into two groups according to body mass index (BMI) classification of WHO.[14]

Group I: Seventy subjects with BMI 18.5-24.9 kg/m² - (Normal weight)

Group II: Seventy subjects with BMI 25.0-29.9kg/m²- (Overweight)

Each group was comprised of equal number of male and female students. The 70 subjects in each group were chosen by Simple Random Sampling method. Thus total of 140 subjects were included in the study.

Inclusion Criteria

- Subjects between 18 to 30 years.
- Healthy male and female subjects.
- Untrained subjects.

Exclusion Criteria

- Subjects below 18 years.
- Subjects above 30 years.
- Smokers.
- Subjects with respiratory illness, any cardiovascular disease, musculoskeletal disease, or any chronic illness.
- Subjects undergoing regular physical training.

All the subjects were asked to refrain from eating for 2 hours prior to exercise. A brief history including smoking history and a clinical examination of respiratory system was done to exclude hidden medical problems that could have negative impact on respiratory responses to exercise testing.

The respiratory parameters (Pulmonary Function Tests, Respiratory Rate) were assessed before and after doing exercise. To determine the BMI, height (in metres), and weight (in kgs) were measured with a standard weighing machine that included a height measuring stand. Weight was measured to an accuracy of 0.5 kg and height to an accuracy of 0.1 cm. The measurements were taken from the participant without shoes and with light clothing and shoulders in relaxed position & arms hanging freely.

The BMI was calculated using formula (Quetelet's Index).[14]

BMI (kg/m²) = weight (kilograms)/ height (m²)

To determine WHR (Waist Hip Ratio), waist circumference was measured around the abdomen on the midpoint between the lower border of the rib cage and the iliac crest, while the participant was standing with the abdomen relaxed, both feet touching and arms hanging freely at the end of normal expiration. Where there was no waist line, the measurement was taken at the level of umbilicus. The hip circumference measured at the greatest gluteal protuberance while the subject stood with the feet together.[12, 13]

WHR = waist circumference (cm) / hip circumference (cm)

RESPIRATORY PARAMETERS

Respiratory parameters: Respiratory Rate was counted by seeing abdominal movements and was counted over 1 minute. Respiratory parameters were evaluated with the help of computerized spirometer Spiro-Exel (Medicaid systems Chandigarh).

Technique

The equipment used was computerized spirometer, spiro-exel (Medicaid systems Chandigarh). It had a turbine flow meter and the range for flow measurement was 0-3L/sec. Range for volume measurement is 0-10L/sec.

Parameters to Be Recorded Were

1. Forced Vital capacity (FVC)
2. Forced Expiratory volume in 1st second (FEV1)
3. FEV1/FVC
4. Peak Expiratory flow rate (PEFR)
5. Forced mid expiratory flow in 0.25-0.75 second FEF (25-75%)
6. Expiratory reserve volume (ERV)
7. Maximum voluntary ventilation (MVV)

Forced Vital Capacity: First of all the subjects were made to sit comfortably and breathe in and out normally to familiarize himself/herself with the equipment. The subjects were then asked to inhale to his/her maximum capacity and then forcefully blow out into the sensor (nose clipped) as hard as possible for as long as possible.[14] Following parameters recorded under forced vital capacity.

1. **FVC:** After the subject has taken in the deepest breath, this is the volume of air which can be forcibly and maximally exhaled out of the lungs until no more can be expired. FVC is expressed in litres. Normal value is 80% of predicted value.
2. **FEV1:** This is the volume of air which can be forcibly exhaled from the lungs in the first second of a forced expiratory maneuver. It is expressed in litres. Normal value is 75-80% of predicted value.
3. **FEV1/FVC:** This is ratio of FEV1/FVC. It indicates what percentage of the total FVC was expelled from the lungs during the first second of the forced exhalation. Normal value is 70% of the predicted value.
4. **PEFR:** This is the maximum flow rate achieved by the subject during the forced vital capacity maneuver beginning after full inspiration and starting and ending with maximal expiration. It can either be measured in L/min or L/sec. Normal value is 380-500L/min or 6-9L/sec.
5. **FEF (25-75%):** It is the mean expiratory flow rate during middle 50% of FVC. It is expressed in liters. Normal value is 3L/min.

Slow Vital Capacity: First of all the subjects were made to sit comfortably and breathe in and out normally to familiarize himself/herself with the equipment. The subjects were then asked to breathe normally into the mouthpiece then expire to the maximum when message “expire to the maximum” appears on the message bar. The background color will also change to yellow. Inspire to maximum slowly when message “Inspire to the maximum slowly” appears on the message bar. The background color will change to green. Breathe normally into the mouthpiece when message “Breathe normally” appears on the message bar. The background color will also become normal. ERV was measured by this technique.

6. **ERV:** It is the extra volume of air that can be exhaled by maximum forceful expiration over and beyond the normal tidal volume. Normal value is 1.l L in normal adult.

Maximum Voluntary Ventilation: First of all the subjects were made to sit comfortably and breathe in and out normally to familiarize himself/herself with the equipment. The subjects were then asked to breathe deeply when message “breathe deeply at a rate of 30 breaths/minute” appears on the message bar and thus MVV was measured.

7. **MVV:** It is the maximum volume of air that can be ventilated on command during a given interval. It is expressed in L/min. Normal adult can attain a maximum ventilation volume of 80-170 L/min (average 100L/min).

Queen’s College Step Test (QCT)[15]: The step test was performed using a stool of 16.25 inches (or 41.30cm) height. Subject stepped up and down on a stool for three minutes at the rate of 24 steps per minute for males and 22 steps per minute for females.

Statistical Analysis: Data was then tabulated and statistically analyzed. Data was reported as mean and their corresponding standard deviation (mean±SD). The values were compared in between different groups using Student’s `t’-test. A p value of <0.05 were considered as significant (S), p <0.01 highly significant (HS), p <0.001 very highly significant (VHS) and p >0.05 as not significant (NS).

Table 1: Age wise distribution of subjects in normal and overweight adult individuals.

Age range	Normal weight groups (n==70)	Overweight group (n=70)
18-19 years	45	46
20-21 years	10	10
22-23 years	10	12
24-25 years	1	2
26-27 years	2	0
28-30 years	2	0

Figure 1: Distribution of patients on basis of BMI.

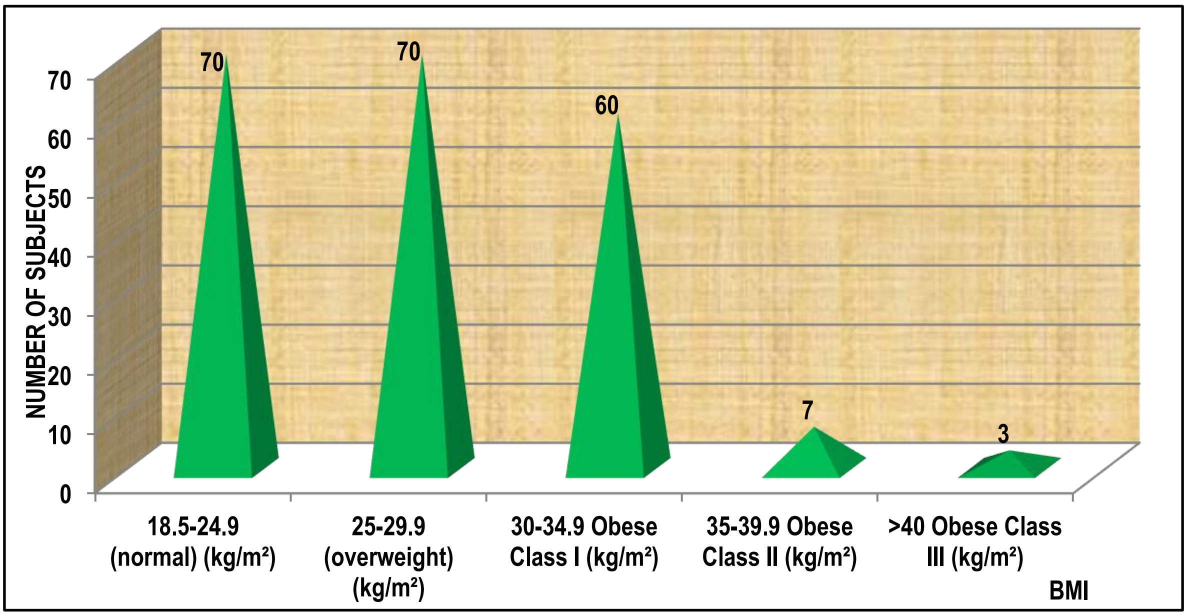

Table 2: Anthropometric & baseline respiratory data of three different groups (mean±SD).

	Normal weight groups (n=70) (mean±SD)	Range	Overweight group (n=70) (mean± SD)	Range	Obese group (n=70) (mean±SD)	Range
Age (years)	19.84±2.75	17-31	19.5±1.77	17-24	19.45±1.99	17-32
Weight (kg)	57.7±7.85	40-75	73±9.71	56-104	83.65±13.34	59-115
Height (m)	162.09±7.97	148-181	163.8±9.76	149-194	159.54±10.52	140-189
BMI (kg/m²)	21.92±1.70	18.4-24.7	27.06±1.34	25-29.4	32.69±3.08	30-46.6
HC (cm)	71.9±9.61	50-89	88.24±7.29	71-99	100.37±6.07	88-118
WC (cm)	99.22±6.60	87-110	104.47±4.04	96-112	111.9±4.96	101-123
WHR	0.72±0.07	0.52-0.84	0.840±0.05	0.71-0.93	0.892±0.05	0.8-0.98
RR (/min)	16.97±3.43	12-26	16.57±3.13	12-24	17.01±3.64	12-26
FVC (lit)	2.61±0.95	1.12-4.8	2.32±0.70	1.25-4.05	2.31±0.70	1.25-4.4
FEV1 (lit)	2.45±0.89	1.05-4.38	2.20±0.66	0.7-3.62	2.19±0.65	1.19-4.14
FEV1/FVC%	94.80±5.43	68.54-100	95.41±3.79	73.39-100	95.51±3.14	85.54-100
PEFR (lit/sec)	6.45±1.45	3.08-9.94	5.85±1.57	3.03-10.25	5.76±1.29	3.34-9.13
FEF 25-75% (lit)	5.09±1.55	2.14-8.26	4.76±1.30	2.08-8.44	4.56±1.13	2.75-7.09
ERV (lit)	1.19±0.37	0.43-1.9	1.07±0.32	0.09-1.56	0.66±0.48	0.08-2.48
MVV (lit/min)	75.91±4.46	60-80	70.92±7.14	60-80	69.92±7.53	60.25-80

Table 3: Comparison of anthropometric and respiratory parameters between males and females.

Para-meters	Group I Normal weight (n=70) (mean±SD)		Statistical signifi-cance p-value	Group II Overweight n=70 (mean±SD)		Statistical signify-cance p-value	Group III Obese n=70 (mean±SD)		Statistical signifi-cance p-value
	Boys	Girls		Boys	Girls		Boys	Girls	
Age (years)	20.45± 3.10	19.22± 2.23	>0.05 N.S.	19.91± 1.80	19.08± 1.66	<.05 S	19.37± 1.30	19.54± 2.52	>0.05 N.S.
Weight (kg)	61.14± 7.46	54.25± 6.72	<0.001 VHS	78.74± 9.12	67.25± 6.34	<0.001 VHS	87.31± 13.38	80± 12.43	<0.05 S
Height (m)	165.65± 8.41	158.51± 5.65	<0.001 VHS	169.71± 9.37	157.88± 5.80	<0.001 VHS	164.11± 11.55	154.97± 6.95	<0.001 VHS
BMI (kg/m²	22.23± 1.53	21.60± 1.82	>0.05 N.S.	27.23± 1.25	26.89± 1.42	>0.05 N.S.	32.21± 1.98	33.16± 3.86	>0.05 N.S.
HC (cm)	79.48± 5.50	64.31± 6.24	<0.001 VHS	94.22± 3.25	82.25± 4.87	<0.001 VHS	104.94± 4.78	95.8± 3.00	<0.001 VHS
WC (cm)	104.68± 3.61	93.77± 3.76	<0.001 VHS	106.85± 3.18	102.08± 3.36	<0.001 VHS	112.02± 5.57	111.77± 4.35	>0.05 N.S.
WHR	0.756± 0.05	0.68± 0.08	<0.001 VHS	0.88± 0.030	0.80± 0.04	<0.001 VHS	0.93± 0.02	0.85± 0.043	<0.001 VHS
RR (/min)	16.97± 3.39	16.97± 3.51	>0.05 N.S.	16.74± 3.24	16.4± 3.05	>0.05 N.S.	17.02± 3.69	17± 3.64	>0.05 N.S.
FVC (lit)	2.75± 0.96	2.46± 0.92	>0.05 N.S.	2.67± 0.74	1.97± 0.44	<0.001 VHS	2.55± 0.83	2.08± 0.459	<0.01 S
FEV1 (lit)	2.61± 0.85	2.30± 0.92	>0.05 N.S.	2.54± 0.67	1.85± 0.46	<0.001 VHS	2.41± 0.77	1.97± 0.42	<0.01 S
FEV1/FVC%	95.87± 5.59	93.74± 5.12	>0.05 N.S.	95.37± 3.23	95.45± 4.33	0.05 N.S.	94.79± 3.18	96.24± 2.98	<0.05 S
PEFR (lit/sec)	6.71±1.53	6.19± 1.33	>0.05 N.S.	6.56± 1.60	5.14± 1.19	<0.001 VHS	6.28± 1.45	5.24± 0.84	<0.001 VHS
FEF 25-75% (lit)	5.46± 1.40	4.72± 1.62	<0.05 S	5.30± 1.27	4.21± 1.10	<0.001 VHS	5.03± 1.24	4.09± 0.79	<0.001 VHS
ERV (lit)	1.16± 0.32	1.21± 0.42	>0.05 N.S.	1.27± 0.13	0.87± 0.33	<0.001 VHS	0.38± 0.18	0.98± 0.47	<0.001 VHS
MVV (lit/min)	75.39± 4.80	76.43± 4.10	>0.05 N.S.	71.34± 7.22	70.51± 7.13	>0.05 N.S.	70.41± 7.40	69.42± 7.74	>0.05 N.S.

RESULTS

The present study included students of MMU, Mullana between the age groups of 18 to 30 years.

Table 1 depicts that out of 70 normal weight subjects; 45 were in the age group of 18-19 years, 10 subjects were in the age group of 20-21 years, 10 in the age group of 22-23 years, 1 in the 24-25 years, 2 subjects in the 26-27 years, and 2 in the age group of 28-30 years. Out of 70 overweight subjects; 46 were in the age group of 18-19 years, 10 subjects were in the age group of 20-21 years, 12 subjects in the age group of 22-23 years, and 2 subjects were in the age group of 24-25 years. The mean age of normal weight and overweight was 19.8±2.75 years and 19.5±1.77 years respectively.

In the above table, 70 were of normal weight with BMI (18.5-24.9) kg/m², 70 were of overweight with BMI (25-29.9) kg/m², and out of 70 obese 60 were under Obese Class I with BMI (30-34.9) kg/m², 7 were under Obese Class II with BMI (35-39.9) kg/m², 3 were under Obese Class III with BMI (>40) kg/m² [Figure 1].

From the above table 2, the mean age of normal weight, overweight and obese groups was 19.8 ± 2.75 years, 19.5 ± 1.77 years, and 19.45 ± 19.9 years respectively. The mean BMI of these three groups was 21.9 ± 1.70kg/m², 27.06 ± 1.34kg/m², and 32.69 ± 3.08kg/m² respectively. The mean WHR of these three groups was 0.72 ± 0.07, 0.84 ± 0.05, and 0.89 ± 0.05 respectively. The mean respiratory parameters of normal weight group were RR 16.97 ± 3.43/min, FVC 2.61 ± 0.95L, FEV1 2.45 ± 0.89L, FEV1/FVC 94.80 ± 5.43, PEFR 6.45 ± 1.45L/sec, FEF 25-75% 5.09 ± 1.55L, ERV 1.19 ± 0.37L, MVV 75.91 ± 4.46L/min.

The mean cardio respiratory parameters of overweight group were RR 16.57 ± 3.13/min, FVC 2.32 ± 0.70L, FEV1 2.20 ± 0.66L, FEV1/FVC 95.41 ± 3.79, PEFR 5.85 ± 1.57L/sec, FEF 25-75% 4.76 ± 1.30L, ERV 1.07 ± 0.32L, MVV 70.92 ± 7.14L/min.

The mean cardio respiratory parameters of obese group were RR 17.01 ± 3.64/min, FVC 2.31 ± 0.70L, FEV1 2.19 ± 0.65L, FVC/FEV1% 95.51 ± 3.14, PEFR 5.76 ± 1.29 L/sec, FEF 25-75% 4.56 ± 1.13 L, ERV 0.66 ± 0.48 L, MVV 69.92 ± 7.53 L/min, PR 80.07 ± 7.42 /min, SBP 113.53 ± 11.90 mmHg, DBP 72.1 ± 6.06 mmHg, MAP 85.91 ± 7.23 mmHg, PP 41.42 ± 9.35mmHg.

The table 3, showed that mean age was different in normal weight boys and girls but the difference was not significant (p>0.05). The mean age difference was significant (p<0.05) in overweight boys and girls but the difference in age was not significant (p>0.05) in obese boys and girls. The mean BMI was different in boys and girls but the difference was not significant (p>0.05) in normal weight, overweight and obese. The mean WHR was different in normal weight boys and girls and the difference was highly significant (p<0.001) and also in overweight and obese boys and girls. The mean RR was different in normal weight, overweight, and obese boys and girls and the difference was not significant (p<0.001) between boys and girls. The mean FVC was not significant (p>0.05) in normal weight boys and girls, and difference was highly significant (p<0.001) in overweight boys and girls, and was significant (p<0.05) in obese boys and girls. The mean FEV1 was not significant (p>0.05) in normal weight boys and girls, and difference was highly significant (p<0.001) in overweight boys and girls, and was significant (p<0.05) in obese boys and girls. The mean FEV1/FVC was not significant (p>0.05) in normal and overweight boys and girls, and was significant (p<0.05) in obese boys and girls. The mean PEFR difference was not significant (p>0.05) in normal weight boys and girls, and difference was highly significant (p<0.001) in overweight and obese boys and girls. The mean FEF 25-75% difference was significant (p<0.05) in normal weight boys and girls, and difference was highly significant (p<0.001) in overweight and obese boys and girls. The mean ERV difference was not significant (p>0.05) in normal weight boys and girls, and difference was highly significant (p<0.001) in overweight and obese boys and girls. The mean MVV difference was not significant (p>0.05) in normal weight, overweight and obese boys and girls.

Table 4: Analysis of Variance (ANOVA)

		Sum of Squares	Degree of freedom	Mean Square	F-value	Significance (p-value)
RR	**Between Groups**	8.352	2	4.176	.359	0.699
	Within Groups	2406.071	207	11.624		
	Total	2414.424	209			
FVC	**Between Groups**	3.870	2	1.935	**3.049**	**0.050**
	Within Groups	131.369	207	.635		
	Total	135.239	209			
FEV1	**Between Groups**	3.110	2	1.555	2.760	0.066
	Within Groups	116.648	207	.564		
	Total	119.758	209			
FEV/FVC	**Between Groups**	20.704	2	10.352	0.577	0.563
	Within Groups	3715.823	207	17.951		
	Total	3736.528	209			
PEFR	**Between Groups**	19.820	2	9.910	**4.734**	**0.010**
	Within Groups	433.345	207	2.093		
	Total	453.166	209			
FEF 25-75	**Between Groups**	9.970	2	4.985	2.764	0.065
	Within Groups	373.320	207	1.803		
	Total	383.289	209			
ERV	**Between Groups**	10.461	2	5.230	**32.828**	**0.000**
	Within Groups	32.982	207	.159		
	Total	43.443	209			
MVV	**Between Groups**	1440.541	2	720.271	**16.914**	**0.000**
	Within Groups	8815.186	207	42.585		
	Total	10255.727	209			

Table 5: Comparison of mean difference between pre vs. post exercise of respiratory parameters (n=70).

Parameters	Mean Difference in normal weight N=70 (mean±SD)	Mean Difference in overweight N=70 (mean±SD)	Statistical significance normal versus overweight (p-value)
RR (/min)	-21.34±9.14	-20.91±7.00	>0.05 NS
FVC (lit)	0.77±1.28	0.11±0.76	<0.001 VHS
FEV1(lit)	0.22±0.96	0.11±0.68	>0.05 N.S.
FEV1/FVC%	2.14±6.87	0.22±3.95	<0.05 S
PEFR (lit/sec)	0.42±1.76	0.24±1.34	>0.05 NS
FEF 25-75% (lit)	0.20±1.59	0.29±1.28	>0.05 NS
ERV (lit)	0.29±0.48	0.05±0.24	<0.001 VHS
MVV (lit/min)	0.08±0.36	0.24±1.14	>0.05 NS

In table 4, with the help of ANOVA test F-value of RR was calculated 0.359 (P<0.699) which showed that variation between the groups and within the groups was not significant. The F-value of FVC was calculated 3.049 (P<0.05) which showed that variation between the groups and within the groups was significant.

F-value of FEV1 was calculated 2.760 (P<0.66) which showed that variation between the groups and within the groups was not significant. With the help of ANOVA test, F-value of FEV1/FVC calculated was 0.577 (P<0.563) which showed that variation between the groups and within the groups was not significant. F-value of PEFR was calculated 4.734 (P<0.01) which showed that variation between the groups and within the groups was significant. F-value of FEF 25-75% was calculated 2.764 (P<0.065) which showed that variation between the groups and within the groups was not significant.

F-value of ERV was calculated with the help of ANOVA 32.828 (P<0.001) which showed that the variation between the groups and within the groups was highly significant. F-value of MVV was calculated 16.914 (P<0.001) which also showed that the variation between the groups and within the groups was highly significant [Table 4].

The mean difference (pre-post exercise) between pre exercise FVC and post exercise FVC in normal weight and overweight groups was 0.77±1.28 L and 0.11±0.76 L respectively. (p<0.001) [Table 5] Similar statistically significant results were obtained on comparing FEV1/FVC% and ERV between the two groups. (p<0.001) [Table 6] However, while comparing the other respiratory variables (RR, FEV1, PEFR, FEF 25-75%) insignificant results were obtained. (p>0.05) [Table 5].

DISCUSSION

In our study, the obese showed lower values of FVC which was statistically significant (p<0.05). & lower values of FEV1 as compared to normal weight groups which was not significant (p>0.05). Low FVC indicated a restrictive pulmonary defect. This may be due to mechanical limitation of chest expansion as accumulation of excess fat interferes with the movement of the chest wall and the descent of the diaphragm. This may reflect intrinsic changes within the lung in the presence of obesity. In obese lipid deposition, cellular hyperplasia, alveolar enlargement, and reductions in the alveolar surface area relative to lung volume occur.[16]

Obese group showed increased values of FEV1/FVC ratio when compared with normal weight group but the difference was not significant (p>0.05). Low FEF25-75% was also found with increasing BMI and the difference of mean values of FEF 25-75% between obese and normal weight groups was significant (p<0.02). Low flow rates are a spirometric signature of obstructive airway diseases. In our study result showed lower value of PEFR in obese than in normal weight and the difference was statistically significant (p<0.01). This occurs when the added weight of the chest wall squeezes the lungs and cause restricted breathing. It is generally accepted that increased body mass loading of the respiratory apparatus (chest & lungs) plays a role in the development of expiratory failure by causing either an insurmountable load to the respiratory muscle or significant ventilation- perfusion inequalities.[17] It is thus suggested that, obesity had also a significant obstructive effect on small airways. This possible explanation may be through the influence of obesity on airway smooth muscle function.

As regards to MVV we noted in our study a statistically highly significant (P<0.001) reduction with increasing BMI. This indicated a defect in respiratory musculature weak effort and coordination, and increased airway resistance among obese. This result can be explained by the deposition of fat between the muscles and the ribs which may decrease chest wall compliance, increasing the metabolic demands and work load of breathing in the obese.[18]

Our study showed decreased ERV in obese group and the difference from normal weight to overweight group was statistically significant (P<0.001). The reduction in ERV can be attributed to a decrease in the mobility of the diaphragm towards the abdomen during inspiration, which is caused by an increased abdominal volume in the obese individuals.[19]

Apart from the reduced movement of the diaphragm as a cause for decreased ERV, Womarck CJ et al.[20] suggested that the main consequence of a burden on the chest wall which is caused by increased adipose mass is the reduction in its compliance, thus making inspiration increasingly difficult and resulting in lower static volumes and flows. There is an increased intra-abdominal pressure with an accumulation of fat in the abdominal cavity. This raises the intra-abdominal pressure due to the visceral obesity and pushes the diaphragmatic muscle upwards, thus causing a compression of the lung parenchyma, especially at the basal region of the lung. Visceral fat produces the over- stretching of diaphragm, thus leading to an elevation of the diaphragmatic domes, which in turn causes a decreased efficiency of the diaphragmatic muscles.[21]

The result of our study agreed with Naimark A et al.[22] who found an increase in pulmonary function in normal weight children and a decrease in pulmonary function of obese children. Significant differences between both groups existed for FVC, FEV1, FEV1/FVC, and FEF25-75%. Another study related with our study, Speiser PW, who found that FVC, FEV1 decreased in obese cases than in normal. They also examined the relationship of WHR to FEV1 & FVC in a large group of subjects and found a strong inverse association between WHR and FEV1, FVC in men but not in women. This difference may be due deposition of fat in different parts of the body.[7]

Our results were also similar to the results of Chen Y Dales R et al[4]. who found that in obesity, airways abnormalities involved a predominant increase in proximal airway resistance but only minimal distal obstruction. The restrictive respiratory impairment in obese subjects is due to increase in body fat which perhaps decrease the chest wall compliance due to associated deposition of adipose tissue around the chest and in the abdomen. This effect seems to be stronger than any increase in lean or muscle mass which may occur in these obese subjects.[10] The trunk obesity or the trunk adipose tissue is the main factor which restricts the movement of the diaphragm.[15]

Our results were also similar to the research[19], who examined pulmonary function test profile and respiratory muscle strength in obese subjects with FEV1/FVC ratio greater than 80%. They found that FVC, FEV1, FEF50%, VC and maximum inspiratory flow rate were significantly lower in obese subjects with low MVV compared with those in whom MVV was normal. They concluded that the standard pulmonary function tests allow recognition of a subgroup of obese subjects without overt obstructive airway disease who have more severe lung dysfunction, the marker of which is a low MVV. Peripheral airway abnormalities may be responsible for these observations.

Mohan V et al. found that waist circumference was negatively associated with FVC & FEV1 and the associations were consistent across sex, age and BMI categories this was explained by the effect of abdominal adiposity on the diaphragm causing limitation of its free movement.[2] Faintuch J et al. found that BMI was positively correlated to FEV1/FVC ratio in adults at all ages and negatively with FVC between 40 to 69 years.[9]

Our results were in accordance with Fabris et al. who examined the respiratory dynamics in obese adult patients. They concluded that respiratory muscle function was markedly impaired in obese patients. Fat excess, particularly visceral obesity, probably interfered with respiratory muscle activity.

Our results disagreed with Lotti P et al[12], who examined healthy normal or mildly obese men. They found that biceps skin fold thickness had the strongest inverse relationship with total lung capacity. However, comparing pulmonary function tests between patients with a WHR less than 0.950 (lower body fat distribution) and subjects with a WHR of 0.950 or greater (upper body fat distribution) revealed that FVC, FEV1 and TLC were significantly lower in the patients with upper body fat distribution. This suggested that upper body fat distribution may be associated with a modest impairment of lung volumes in normal and mildly obese men. Thus both obesity itself and the pattern of body fat distribution have independent effects on ventilatory function. Relative adiposity as measured by BMI had a significant effect on ventilatory function. This supports the hypothesis that obesity affects the respiratory function by multiple mechanisms in addition to the direct mechanical effect on the abdominal and chest wall as fat is a metabolically active tissue.

In our study, respiratory parameters in response to exercise were decreased in all groups. Respiratory parameters response to exercise was found to be decreased with increase in BMI. Ventilatory limitation, desaturation and impaired O_2 transport/utilization to the periphery appear to be the principal factors limiting exercise.

Obesity impairs performance in most athletic events. Some researchers pointed out that obesity did not affect sub maximal walking economy, and then therapeutic exercise programs for obese adolescents are best designed to increase caloric expenditure and decrease body fat rather than to improve aerobic fitness.[13,19]

RR was significantly increased in all groups with exercise, resulting in an increase in minute ventilation. The increase in minute ventilation with exercise is linearly related to both CO_2 production and O_2 consumption at low to moderate levels. Ventilation increases abruptly in the initial stages of exercise and is then followed by a more gradual increase. The rapid rise in ventilation at the onset of exercise is thought to be attributable to motor centre activity and afferent impulses from proprioceptors of the limbs, joints and muscles. Arterial oxygen and carbon dioxide tensions are not sufficiently abnormal to stimulate respiration during exercise. Sensitivity of peripheral chemo receptors to oscillations in Pao_2 and $Paco_2$ is responsible for increasing ventilation. Other theories are that the rise in body temperature may play a role, or that collateral branches of neurogenic impulses from the motor cortex to active muscles and joints may stimulate the brain stem and respiratory centre leading to hyperpoea.[21]

Our study agreed with Watson RA[19], who examined that there was difference in FEV1, FVC, PEFR in both obese and normal weight subjects after exercise but the difference was not significant ($P>0.05$).

Pelosi P et al[15], reported that the group mean percentage falls in FEV1 and FEF were significantly greater in the obese group than in the controls after the exercise challenge on a treadmill test. Rasslan Z, indicated that pulmonary responses in obese individuals based on predicted exercise capacity is more important than whether a ramp or step treadmill exercise test is used.[13]

The mean difference between respiratory parameters before and after exercise was decreased as BMI increased. This may be because obesity possesses additional stress on respiratory system. Obesity can cause various deleterious effect to respiratory function such as alterations in respiratory mechanics, decrease in respiratory muscle strength and endurance, decrease in pulmonary gas exchange, lower control of breathing, and limitations in pulmonary function tests and exercise capacity.[9-13] These changes in lung function are caused by extra adipose tissue in the chest wall and abdominal cavity, compressing the thoracic cage, diaphragm, and lungs. The consequences are a decrease in diaphragm displacement, a decrease in lung and chest wall compliance, and an increase in elastic recoil, resulting in a decrease in lung volumes and an overload of inspiratory muscles.[10] These changes are worsened by an increase in the BMI.[14]

Though our study is by no means exhaustive it does provides a glimpse into the variety of alterations in respiratory function that occur as excessive adipose tissue accumulates, even in the absence of overt disease. The individuals with obesity are more likely to find it physiologically difficult to participate in physical activities that require movement of their increased body mass. Further research is recommended to have a more complete understanding of this condition. Promoting physical activity is a priority in this context and attention should not just be focused on more participation in sports club but should also stimulate normal outdoor activities, such as a walking and cycling and discouragement of 'sedentary behaviour'.

CONCLUSION

- The mean RR was more in obese as compared to normal weight subjects although the increase was not significant ($p>0.05$). In response to exercise, RR was significantly ($p<0.001$) increased in all three groups i.e. normal weight, overweight, and obese subjects. The mean difference between boys and girls in all groups was found to be not significant ($p>0.05$).
- The mean FVC values was significantly ($p<0.05$) reduced in obese subjects as compared to normal weight subjects. In response to exercise FVC was very highly significantly ($p<0.001$) reduced in normal weight and it was also reduced in both overweight and obese groups although it was not significant ($p>0.05$). It was reduced in girls as compared to boys in all groups, the mean differences between boys and girls were not significant ($p>0.05$) in normal weight, very highly significant ($p<0.001$) in overweight, and the difference was significant ($p<0.01$) in obese.
- The mean FEV1 was reduced with increasing BMI in overweight and obese but the reduction was not significant and in response to exercise FEV1 was reduced in girls as compared to boys but the reduction was found to be very highly significant in overweight and significant in obese and not significant ($p>0.05$) in normal weight.
- FEV1/FVC was increased with increasing BMI in overweight and obese but the increase in ratio was not significant and in response to exercise. FEV1/FVC was reduced in normal weight but the change was not significant in overweight and obese ($p>0.05$). The ratio was reduced in normal weight girls, although was not significant ($p>0.05$), and it was increased in overweight and obese girls which was significant ($p<0.05$) in obese but not in overweight girls.
- PEFR was decreased with increasing BMI and it was significantly ($p<0.05$) reduced in obese and overweight as compared to normal weight. In response to exercise, it is reduced in all the three groups and the reduction was significant ($p<0.05$) in normal weight but not significant ($p>0.05$) in overweight and obese.
- The mean FEF25-75% was reduced with increasing BMI and reduction was significant ($p<0.02$) in obese as compared to normal weight. In response to exercise, it was reduced in all the three groups but the reduction was not significant ($p>0.05$). It was very highly significantly ($p<0.001$) reduced in overweight and obese and significantly ($p<0.05$) in normal weight girls.
- The mean ERV was reduced with increasing BMI. The reduction was significant in normal weight vs. overweight, and very highly significantly in obese vs. overweight and obese vs. normal weight. In response to exercise it was reduced very highly significantly ($p<0.001$) in normal weight, significantly ($p<0.05$) in obese and was not significant ($p>0.05$) in overweight.
- The mean MVV was very highly significantly ($p<0.001$) reduced in all groups with increasing BMI. In response to exercise, MVV was reduced but not significantly ($p>0.05$) in all the three groups. No significant change was found in mean MVV between boys and girls of all groups.

REFERENCES

1. WHO. Obesity: Preventing and managing the global epidemic. Report of a WHO technical report series No. 894, 2000;i-xii,1-253.
2. Mohan V, Deepa R. Obesity and abdominal obesity in Indian. Indian J Medical Res 2006;123:593-6.
3. Patkar KU, Joshi AS. Comparison of Vo2max in obese and non-obese young Indian population. Indian J Physiol Pharmacol 2011;55:188-92.
4. Chen Y Dales R, Tang M, Krewski D. Obesity may increase the incidence of asthma in women but not in men: longitudinal observations from the Canadian National Population Health Surveys. Am J Epidermiol 2002; 155: 191-7.
5. De Lorenzo A, Petrone-De Luca P, Sasso GF, Carbonelli MG, Rossi P, Brancati A. Effects of weight loss on body composition and pulmonary function. Respiration 1999;66:407-12.
6. WHO. Obesity: Preventing and managing the global epidemic. Report of a WHO consultation. World Health Organ tech Rep Ser2000; 894: 1-253.
7. Speiser PW, Rudolf MC, Anhalt H, Hubner CC. On behalf of the Obesity Consensus Working Group: Childhood Obesity. J Clin Endoc Metab 2005;90:1871-7.
8. Kumanyika SK, Obarzenak E, Stettler N, Bell R, Field AE, Fortmann SP et al. Population Based Prevention Of Obesity. The Need For Comprehensive Promotion Of Healthful Eating, Physical Activity, and Energy Balance: A Scientific Statement from American Heart Association Council on Epidemiology and Prevention, Interdisciplinary Committee for Prevention. Circulation 2008;118:428-64.
9. Faintuch J, Sonza SAF, Valexi AC, Santana AF, Gama-Rodrigners JJ. Pulmonary function and aerobic capacity in asymptomatic bariatric candidates with very severe morbid obesity. Rev Horp clin Fac Med S Paulo 2004;59:181-6.
10. Koenig SM. Pulmonary complications in obesity. Am J Med Sci 2001; 321:249-79.
11. Ladosky W, Botelho MAM, Albuquerque JP Jr. Chest mechanics in morbidly obese non hypo ventilated patients. Respir Med 2001;95: 281-6.
12. Lotti P, Gigliotti F, Tesi F, Stendardi L, Grazzzini M, Duranti R et al. Respiratory muscles and dyspnoea in obese non-smokers subjects. Lung 2005;183:311-23.
13. Rasslan Z, Junior RS, Stirbulov R, Fabbri RMA, Lima CAC et al. Evaluation of pulmonary function in class I & II obesity. J Bras Pneumol 2004;30:508-14.
14. Jones RL, Nzekwu MMU. The effects of body mass index on lung volumes. Chest 2006;130:827-33.
15. Pelosi P, Croci M, Ravagnan I, Tredici S, Pedoto A, Lissoni A, et al. The effects of body mass on lung volumes, respiratory mechanics, and gas exchange during general anesthesia. Anesth Analg 1998;87:654-60.
16. Sharp JT, Henry JP, Sweany SK, Meadows WR, Pietras J et al. Effects of mass loading the respiratory system in man. J Appl Physiol 1964;19: 959-66.
17. Collins LC, Hoberty PD, Walker JF, Fletcher EC. The effect of body fat distribution on pulmonary function test. Chest 1995;107:1298-1302.

18. Ray CS, Sue DY, Bray G, Hansen JE, Wasserman K. Effects of obesity on respiratory function. Am Rev Respir Ris 1983;128:501-6.
19. Watson RA, Pride NB. Postural changes in lung volumes and respiratory resistance in subjects with obesity. J Appl Physiol 2005;98:512-7.
20. Womarck CJ, Harris DL, Katzel LI, Hagberg JM, Bleecker ER, Goldberg AP et al. Weight loss, not aerobic exercise improves pulmonary function in older obese men. Journal of Gerontology: Medical Sciences 2000;55:453-7.
21. Thomas PS, Milledge JS, Cowen ER, Hulands G. Respiratory function in the morbidly obese before and after weight loss. Thorax 1989;44:382-6.
22. Naimark A, Cherniack RM. Compliance of respiratory system and its components in health and obesity. J Appl Physiol 1960;15:377-82.

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