Research article

A comparative study of FVC, FEV1, FEV1/FVC ratio before and after cycling in young obese and non-obese women

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ABSTRACT

Introduction and Aim: Obesity is becoming a worldwide problem and women were more likely to be obese than men in all regions of world. Obesity affects multiple systems of the body including respiratory system. This study aimed at comparing the respiratory functions before and after cycling in obese and non obese young women.

Materials and Methods: One hundred healthy female in the age groups of 18-25 years were considered. Fifty subjects were obese [BMI>25 kg/m2] and 50 were age matched non obese [BMI=18 to 22.9 kg/m2]. Anthropometric measurements weight, height, waist circumference, hip circumference were measured. BMI and waist hip ratio were calculated. Spirometric parameters like FVC (Functional Vital Capacity), FEV1 (Forced expiratory volume 1 second), FEV1/FVC ratio were assessed before cycling. Cycling (a graded submaximal exercise) was performed using YMCA cycling protocol. Spirometric parameters were assessed within 5 minutes from termination of cycling. Data collected were statistically analyzed using paired 't' test.

Results: Before cycling and after cycling values of FVC, FEV1/FVC in obese young women were lower ($p<0.0001$) compared to non obese young women but their values were within normal range of % prediction. On comparing the FVC, FEV1, FEV1/FVC values from before to after cycling there was statistically significant reduction in both the groups. On comparison of reduction in spirometric values from before to after cycling, among obese and non obese young women, it was not statistically significant.

Conclusion: Both in before and after cycling the obese young women had reduced pulmonary function test compared to non obese young women but values within the normal percentage of prediction.

Keywords: FEV1; FVC; FEV1/FVC; obese young women.

INTRODUCTION

Obesity is becoming a worldwide problem affecting all levels of society of both developed and developing countries. The prevalence of obesity worldwide is nearly doubled in between 1980 to 2008. (1). Globally, women tend to be more obese than men, particularly in southeast Asian countries where women tend to be twice as obese as men (1). Reports on natural history have shown obesity to be a key factor associated to several chronic and non-chronic diseases e.g., hypertension, diabetes mellitus (DM), dyslipidemia, sleep apnea and altered respiratory functions, polycystic ovarian syndrome, intertriginous infections, psychosocial problems, etc., (2). Obesity can cause various deleterious effects on respiratory functions, 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 (3).

Obese individuals may demonstrate tolerance or intolerance to a task that normal subjects would find tolerable. Thinking in same line, what will happen to the spirometric parameters like FVC, FEV1, and FEV1/FVC immediately after same amount of exercise among obese and non-obese women. This study was carried out with the objectives to measure the variation in FVC, FEV1, and FEV1/FVC before and after cycling in non-obese and obese young women and to compare the differences in FVC, FEV1, and FEV1/FVC parameters among the study groups.

MATERIALS AND METHODS

A comparative study was conducted over 24 months on 100 female subjects, carried out at Department of Physiology, Mysore Medical College Mysuru. The study protocol was approved by the college Ethical Committee (dated 13.11.2013) and informed consent was obtained from all participating subjects after briefing the research intention. A detailed history was taken of self-willing subjects like gender, age, etc. Exclusion criteria included history of hypertension, DM, respiratory disorder, musculoskeletal abnormalities and neuromuscular disorder or history of vigorous active sports training, aerobic exercise in last 6 months, habit of alcohol consumption or history of any drug intake. Inclusion criteria included women aged 18 to 25 years (10). Among them 50 were obese

with BMI >25 kg/m2 and 50 non-obese with BMI=18 to 22.9 Kg/m^2. The subjects selected were given specific dates to visit the department between 10.30 a.m to 1.00 p.m hours and all subjects were instructed to refrain from intake of heavy breakfast at least 2 hours prior to the test and avoid hot drink like coffee, tea, or any other stimulant before test. Anthropometric measurements: Height (meter), weight (kg), waist circumference (cm), hip circumference (cm), BMI was calculated (2). The parameters recorded at rest were heart rate (bpm), BP (mm of Hg), SpO_2%, FVC, FEV1, FEV1/FVC that was measured using spirometer. Subject was asked to cycle on bicycle ergometer following YMCA cycling protocol. Post cycling FVC, FEV1, and FEV1/FVC (6) were measured using spirometer and pulse and blood pressure were measured after 5 minutes after termination of cycling for recovery.

Descriptive statistics was used for before and after cycling data, and paired "t" test was used to analyze the difference in means among same group and different groups. p-value of <0.05 was considered as level of statistical significance.

RESULTS

The study included 100 women, 50 of whom were obese and 50 of whom were not obese Paired 't' test was applied for all the spirometric parameters, to find any significant difference between the means of the two groups. In all the above tests, 'p' value less than 0.05 was taken as statistically significant. Table 1 shows the comparison anthropometric parameters before cycling in non-obese and obese young women.

Table 1 shows comparison of age, weight, height, BMI, waist circumference, hip circumference, waist/hip ratio of non-obese and obese young women. The statistics revealed very significant difference in all the above-mentioned parameters (p<0.0001) among both groups. Table 2 shows the vital parameters before and after cycling in non-obese and obese young women.

Table 1: Comparison of anthropometric parameters before cycling in non-obese and obese young women

Parameters	**Non-obese (n=50)**	**Obese (n=50)**	**p value**
Weight (Kg)	49.6± 4.30	63.76± 6.59	<0.0001*
Height (M)	1.58± 0.0643	1.55± 0.0613	0.0189*
BMI (Kg/M^2)	19.82± 1.39	26.54 ±1.52	<0.0001*
Waist Circumference(cm)	81.28± 3.09	92.92± 4.32	<0.0001*
Hip Circumference(cm)	90.80± 4.54	99.76± 4.41	<0.0001*
Waist / Hip Ratio	0.89± 0.04	1.07± 0.04	<0.0001*

Table 2: Vital parameters before and after cycling in non-obese and obese young women

Parameters	**Non -obese women(n=50)**		**Obese women(n=50)**	
	At rest	5 min after terminating cycling	At rest	5 min after terminating cycling
HR in bpm	79.82	80.13	81.94	83.03
B.P.in mm of Hg	108/68	116/78	116/77	120/82
SpO2 in %	96.6	96.82	96	96.12

Table 3: Comparison of spirometric parameters in non-obese and obese young women before and after cycling.

Parameters	**Non-obese**				**Obese**			
	Before cycling Mean± SD	After cycling Mean± SD	t value	P value	Before cycling Mean± SD	After cycling Mean± SD	t value	P value
FVC (%)	97.8±2.46	93.6±2.46	22.95	<0.001	92.3±4.56	87.6±7.03	7.54	<0.001
FEV1 (%)	98.4±1.07	94.3±1.43	22.11	<0.001	98±6.83	91.9±10.07	5.5	<0.001
^FEV1/FVC ratio (%)	85.11±3.63	85.11±3.63	0.82	0.41	90.02±7.9	88.49±8.9	1.51	0.13

Table 4: Comparison of change(reduction) of FVC, FEV1, FEV1/ FVC among non-obese and obese young women from before to after cycling

Spirometric variables	Change in parameters before and after cycling in women		**t value**	**p value**
	Non-obese	**Obese**		
FVC (%)	4.2	4.6	-0.71	0.47
FEV1 (%)	4.16	6.09	-1.72	0.08
FEV1/FVC ratio (%)	0.35	1.53	-1.06	0.28

Table 3 shows comparison of FVC, FEV1, FEV1/FVC before and after cycling that revealed statistically significant difference in FVC, FEV1 ($p<0.001$) in both nonobese and obese groups and there was no statistically significant difference observed in variable of FEV1/FVC ratio between before and after cycling in both non-obese and obese groups. Table 4 shows comparison of change (that is reduction) of FVC, FEV1, FEV1/ FVC among non-obese and obese young women from before to after cycling, there was no statistically significant difference observed.

DISCUSSION

Obesity affects multiple systems of the body, including the respiratory system. The present study intended to view at what happens to spirometric parameters FVC, FEV1, and FEV1/FVC ratio in obese young women before and after an exercise testing (cycling) when compared with non obese young women. Exercise testing makes the symptoms apparent which were not apparent at rest in obese. Examples may be breathlessness or exercise induced bronchospasm [EIB] or reduction or no change.

Review of literature shows varied reports on the effects of exercise testing on spirometric parameters such as FVC, FEV1, and FEV1/FVC ratio. While few studies have concluded that following exercise testing there was reduction in spirometric parameters in obese individuals (4, 5), yet few other studies no change in the spirometric parameters in obese individuals was reported (6). There could be many reasons for such diverse reports. Multiple factors affect the respiratory function tests like age, gender, height, weight, and ethnic population (7), posture while measuring. Different technology-based instruments are used for measurement of same parameter (8). A lot depends on the subject's cooperation and effort during the procedure and the different modes of exercise (cycling, tread mill, 6 min walk test) used in exercise testing. Individuals considered as obese based on BMI as per the International WHO classification (9), there are sub classes of obesity and these sub classes are not mentioned in classification recommended for Indian population by Indian Health ministry (10).

Comparison of spirometric parameters (FVC, FEV1, FEV1/FVC ratio) before cycling in non-obese and obese young women

On comparing the results of spirometric parameters of before cycling in non-obese and obese young women, showed that there is significant reduction in FVC except for FEV1 and FEV1/FVC in obese women and their percentage of prediction was within normal range. In this study there is reduction in FVC in obese compared to non-obese may be because of abdominal obesity as abdominal circumference and waist hip ratio in obese women is more than normal (11,12). This indicates that there is an interference with diaphragm movement by abdominal fat and chest wall excursion (13). The reduction in FEV1 is not significant in obese and its percentage of prediction is in normal range, indicating there is no obstruction to expiration. FEV1/FVC ratio is increased in obese compared to non-obese young women similar result was seen in study done by Ajmani *et al.,* (14) and Kalpana *et al.,* (15). FVC decrease is supported by Joshi *et al.,* (16) showing negative correlation with body fat percentage in young female and ERV is reduced in obese women (17). The FEV1 being normal in resting state (before cycling) in obese young women is contradicting to the results in a study by Leone *et al., (*18) on large French population indicating that decrease FEV1 in normal BMI with increased mild abdominal obesity in both women and men (18, 20).

Comparison of spirometric parameters (FVC, FEV1, FEV1/FVC ratio) after cycling in non-obese and obese young women

Comparison of spirometric parameters after cycling in non-obese and obese young women showed a significant reduction in FVC, FEV1/FVC ratio, except for FEV1 in obese women. Our result is similar to results of Moradi *et al.,* (19). The reduction in FEV1 is not significant in obese and its percentage of prediction is normal. Therefore, it indicates no obstruction to expiration, supported by Moradi *et al.,* (4,19), Leon *et al.,* (18). This decrease in spirometric parameters (FVC, FEV1/FVC ratio) after cycling (exercise test) in obese implies that there is decreased available ventilatory reserve to meet the increasing ventilatory demands, as a result of increased ventilatory muscle function (4). Obesity and exercise effects respiratory system by different ways. Obesity specifically abdominal fat and chest wall fat opposes the expansion of the ribcage and lungs. Abdominal load opposes the diaphragmatic movement upward as well as downward (20). The mechanical properties of lung are altered during exercise in both obese and non obese women. The spirometry parameters are highly dependent on the mechanical properties of lung (4).

Comparing the spirometric parameters FVC, FEV1, FEV1/FVC ratio before and after cycling in non-obese young women

FVC, FEV1, FEV1/FVC ratio was recorded before submaximal cycling and within 5 min after termination of cycling in non-obese young women. In present study there is significant reduction in FVC, FEV1 from before to after cycling in non obese young women. FEV1/FVC ratio did not show any subjects post exercise challenge statistically significant difference from before to after cycling. This result was supported by Moradi *et al.,* (4), Gowdhami *et al.,* (5), showed that in non-athletic normal weight there is decrease in FVC, FEV1 breathing with room air. The

decrease in FEV1 following exercise is due to decrease in FRC during heavy exercise as expiratory flow is limited at peak of exercise which is well tolerated in lean individuals (21). When considering FEV1 alone, its reduction in post cycling in non-obese women is similar to results of study by Moradi *et al.,* (19, 21) while result of Ganji *et al.,* (6) contradicts it.

Comparing data on spirometric parameters before and after cycling among obese young women

It was shown that there is significant reduction in FVC, FEV1 from before to after cycling in obese young women. While FEV1/FVC ratio do not show any significant decrease following cycling. This was supported by results of Moradi *et al.,* (4), Gowdhami *et al.,* (5), Moradi *et al.,* (19), Devershetty *et al.,* (22) showed that in obese subjects both in men and women post exercise challenge there is fall in FVC, FEV1. Due to increase in the ventilator muscle activity to meet the increased demand there is decrease in the available ventilator reserve (1,4). A study showed temporary reduction in residual lung volume by 21% during recovery from exercise, preventing complete exhalation to occur and causing reduction in FVC post exercise which was like our results (23). Obesity and exercise effects respiratory system in different ways. Obesity specifically abdominal fat and chest wall fat opposes movement on the ribcage and lungs. Abdominal load pushing up on the diaphragm and its downward movement (20). So, there may be decrease in the FVC in obese. The mechanical properties of lung are altered during exercise. The spirometry parameters are highly dependent on the mechanical properties of lung (4). Increased levels of anti-inflammatory adipokines and proinflammatory adipokines in obese may result due to premature closure of the inflamed and edematous smaller airways which explain the decrease in FEF 25%-75% in obese (3). Intense exercise heavily influences the air way resistance (4). FRC (hyperinflation) in obese is already reduced in resting state, on heavy–to-peak exercise it may result in increment in FRC to tolerate the decline in expiratory flow. Reduction of tidal volume and rise in respiratory rate may indicate dynamic hyperinflation and during peak exercise may be due to reduction of ventilator reserve (3, 21).

EELV is determined by respiratory mechanics and respiratory muscle recruitment during exercise, and it influences in tidal expiratory flow during exercise (1), work of breathing and shortness of breath.

Comparison of change from before to after cycling in non-obese and obese young women

The change brought about from before cycling to after cycling in both non-obese young and obese young women is only reduction. In context to this reduction, it noticed that reduction seen in all the spirometric parameters in obese is more than non-obese but not statistically significant. Mojtaba *et al.,* (24) acute effect of single bout of exercise in obese men had no significant difference in spirometric parameters before and after it, supported this result. This result is contradicted by study done by Chlif *et al.,* (25) which stated mechanical constraints increase progressively with degrees of obesity contributing to exercise limitation in obese subjects (1).

CONCLUSION

Young obese women have spirometric parameters similar to that of non-obese women even during post cycling. Hence, obese young women can use cycling safely as an exercise mode. The results of this study give scope for future studies with different age groups, genders, and exercise training tests.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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