ORIGINAL RESEARCH PAPER

Volume-7 | Issue-1 | January-2018 | PRINT ISSN No 2277 - 8179

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

EVALUATION OF PULMONARY FUNCTION TEST [SPIROMETRY] IN PATIENTS WITH METABOLIC SYNDROME IN INDRAPRASTHA APOLLO HOSPITALS, NEW DELHI

Medicine

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ABSTRACT

Aim of study:- To evaluate spirometry in patients with Metabolic Syndrome exclusively for Asian men and women.

Objective of study:- To look for restrictive, obstructive and mixed pulmonary defect among patients of metabolic syndrome.

Study design:- All admitted patients who were planned for any surgery by general anesthesia were selected. In pulmonary function test, obstructive lung impairment was considered when FEV1-to-FVC ratio was less than 0.70 and an FVC was more than equal to 80% of the predicted value. Restrictive lung impairment was considered when FVC was less than 80% of the predicted value and an FEV1-to-FVC ratio was more than equal to 0.70. Mixed lung impairment was considered when FEV1-to-FVC ratio was less than 0.70 and FVC was less than 80% of the predicted value.

Salient findings of results:- 100 patients were studied. Restrictive pulmonary defect was in 58%, mixed pulmonary defect was in 8% individuals, whereas 34% subjects had normal pulmonary function. Mean age with normal pulmonary function test was 53.53years; mean age with mixed defect was 65 years. Lung function in these patients was not found to be dependent on sex, height, weight, waist circumference, body mass index, antihypertensive medication, smoking, alcohol drinking, physical activity, high density lipoprotein and triglyceride level.

Conclusion:- Metabolic syndrome is associated with impaired lung function, predominantly restrictive type. With increasing age, mixed pulmonary defect is found to be associated.

KEYWORDS

Spirometry, obstructive, restrictive

INTRODUCTION

Metabolic syndrome was first described by Kylin1 in the 1920s for the clustering of hypertension, hyperglycaemia and gout. It is also named 'Syndrome X', 'The Deadly Quartet' and 'The Insulin Resistance Syndrome'. Now 'metabolic syndrome' term remains the most widely accepted description of this cluster of metabolically related cardiovascular risk factors that predict a high risk of developing diabetes and coronary artery disease(CAD)[2,3]. It is well defined by 2005 revised NCEP ATP III guideline as proposed by the AHA/NHLBI. (This guideline is exclusively for Asian Men and Women)4. Although there are many definitions of Metabolic Syndrome, but the uniform pathophysiology is insulin resistance. Genetic susceptibility, largely mediated through a private mutation in HNF1A encoding hepatic nuclear factor-1a and a 'westernization' of lifestyle over the past 50 years, alongside this rising tide of diabetes has doubled hospitalizations for Chronic heart disease (CHD), despite declining rates in the general population5. Even small increase in fasting or postprandial glucose increases risk for cardiovascular morbidity and mortality[6]. Spirometry is a very simple non-invasive test for assessing pulmonary function. It gives an important clue about obstructive, restrictive and mixed defect of lung function.

REVIEW OF LITERATURES

Metabolic syndrome was associated with lung function impairment independently of body mass index. Low chest wall compliance and high peripheral airway resistance are the possible mechanisms for the abnormal lung function tests in obese patients[7]. Dyslipidemia, leptin and elevated heart rate are independent risk factors for greater susceptibility to lung function impairment, whereas elevated amylin is protective8. An increased incidence of diabetes and insulin resistance can lead to the largely unexplained correlation between lung function and incidence of CVD[9]. Abdominal fat is known to produce potentially harmful levels of cytokines which may also be associated with impaired pulmonary function and cardiovascular diseases[10,11]. Elevated insulin levels due to increased insulin resistance have been found to have mitogenic effects on the airway smooth muscle and also result to induce a hypercontractile phenotype on these cells[12]. But the prediction equation for normal pulmonary function may also be a problem, even after standardization for sex, and height, age, as a single prediction equation can not exactly reflect the normal pulmonary function of the overall population, considering the wide age range[13,14]. An association was seen between restrictive pattern and metabolic syndrome in older population in terms of insulin resistance[15,16]. Mean while, type 1 diabetes has been found to be predominantly associated with features of restrictive pattern, concluding a link between endocrine disorders and impaired lung function[17,18,19]. The association of C-reactive protein with metabolic syndrome is significant, as previously reported in many studies[20,21,22], but is largely dependent on waist circumference. Specifically, a highly elevated C-reactive protein level is not likely to be strongly associated with metabolic syndrome than a comparison between moderate CRP and moderate-to-severe restrictive pulmonary function defect[23,24]. Impaired restrictive lung function might be present with metabolic disorders in a severity dependent manner in a population who are apparently healthy[25]. Association of ventilator function with cardiovascular mortality would be affected at least partially mediated by insulin resistance[26]. Even moderate physical activity in men with less fitness level is seemed to dramatically decrease the likelihood of developing the metabolic syndrome[27]. It has markedly increased in Korea over the 1998–2001 periods, mainly because of two culprits- dyslipidemia and abdominal obesity[28]. Ross lazaruset al has suggested that abnormal pulmonary ventilator function should be added to the already long list of adverse result of excess adiposity[29]. Reduced FVC paired with metabolic syndrome was correlated with an increased risk of mortality[30]. There is a significant effect of alteration in body mass on the level of FEV1 and FVC[31].Lower vital capacity has been found to be a predictor of diabetes in Western countries[32,33,34]. Pradeep et al found no association between hypertension and pulmonary function test in obese; similarly no association was seen between diabetes and PFT in obese[35]. With the advent of computerized spirometry, analysis of flow-volume loops is

found to have great help to the obese36.Swapnil J. Paralikar et al showed Lung function impairment, particularly decreased MVV and reduced FEV1/FVC ratio, was found in subjects of obesity in adolescence[37]. Sookyoungkim et al showed decreased Vital capacity in Korean adult males was correlated with metabolic syndrome irrespective of obesity38.Veena C N et al showed a significant decrease in the values of PEFR and mean FEF 25-75(L/S) suggesting an obstructive pattern of lung disease in obese diabetic subjects[39]. Metabolic pathways associated with hyperglycemia make lungs to be potential targets[40]. Joey C. Eisenmann et al showed a decrease pulmonary function in obese children41. P.Satyanarayana et al said that lung function impairment particularly decreased FVC and FEV1 were correlated with obesity in adolescents[42]. Significantly lower pulmonary function was found with metabolic syndrome or diabetes mellitus in Fawn et al study[43]. Emel Torun et al found overweight, obese and morbidly obese children had no obstructive pulmonary defect compared to healthy lean subjects44. Sharlin B. Christian et al showed that FVC, FEV1, PEFR decrease in overweight and obese subjects[45]. Ramya K et al showed increasing BMI resulted in defective lung functions46.G. K. Sudhir et al showed FVC was significantly raised in the obese group compared to the normal[47]. The more metabolic syndrome components in man have more severe pulmonary dysfunction[48].

Aims and Objectives:

Aim of our study is to evaluate the Pulmonary function Test in patients with Metabolic Syndrome exclusively for Asian men and women who will fulfill 2005 Revised NCEP ATP III criteria as proposed by AHA/NHLBI.

Objective of our study is to look for restrictive, obstructive and mixed pulmonary defect among these 100 metabolic syndrome patients.

Materials and Methods

STUDY LOCATION

Study was conducted at Indraprastha Apollo hospitals, Sarita vihar, New Delhi. This is a 725 bedded super speciality hospital with all possible diagnostic and therapeutic modalities for research purpose. The study was conducted from July 2014 to February 2016 and 100 patients studied. The approval of institutional ethics committee was taken.

Patients with metabolic syndromes who are admitted in indoors for surgeries done under general anaesthesia are more prone to intraoperative and postoperative complications. It has been seen in our institute in many cases to develop respiratory symptoms initially followed by worsening of general condition. Pulmonary function test serves as a non-invasive tool to detect the impaired lung function earlier to take additional precaution both in intraoperatively and postoperatively.

Type of study

This was observational comparative study.

Study population

Patients who are admitted in Indraprastha Apollo hospitals, New delhi for various reasons like preoperative evaluation for surgeries done under general anaesthesia (without having any known pulmonary co-morbidity).

STUDY DESIGN AND SAMPLE SIZE

All patients presented to Indraprastha Apollo Hospitals & diagnosed as a case of Metabolic Syndrome as per criteria described before was enrolled in this study. Proper history and relevant data of general physical examination and investigations were collected. After taking informed consent, spirometry was performed in all these patients. In pulmonary Function Test- FVC (Forced Vital Capacity), FEV1/FVC ratio, had been studied. Sample size was 100 which were justified in statistical analysis.

Inclusion criteria

Patients who fulfilled 2005 Revised NCEP ATP III criteria as proposed by AHA/NHLBI identified as Metabolic Syndrome.
If minimum 3 out of 5 criteria fulfilled below-

1. Abdominal obesity [Waist circumference Asian Men>90cm Asian Women>80cm]
2. Serum triglycerides-more or equal to 150mg/dl
3. HDL Cholesterol- Men<40mg/dl Women<50mg/dl
4. Blood pressure- Systolic more or equal to 130mm Hg Diastolic more or equal to 85mm Hg
5. Fasting glucose more or equal to 100mg/dl

But the patients who are on antihypertensive medication or on anti-diabetic medication at the time of study were considered to be positive for the respective component of the criteria mentioned above.

Exclusion criteria-

1. Patients having asthma or COPD or any chronic lung disease for more than 2 years.
2. Patients who refuse to give consent for this study.

Data collection technique and tools -

Indoor patients who were fit in diagnostic criteria for metabolic syndrome were explained about the study and written consent was taken. Smoking, alcohol drinking, and physical activity histories for each patient were recorded in the proforma. Current, former, and never smokers were defined as those who reported the current use, any prior use, and no use of cigarettes, respectively, at the time of survey. Current and never alcohol drinkers were defined as those who reported drinking alcohol at least 1 time/week and less than 1 time/week, respectively. Physical activity was divided into three levels. Mild physical activity was defined as those who exercised less than 1 hour/week. Moderate physical activity was defined as those who exercised between 1 and 4 hour/week. Vigorous physical activity was defined as those who exercised more than1 hour/week.

Blood pressure was measured using a mercury sphygmomanometer with the participants in the sitting position after 5 min of rest. The Height was measured with a calibrated meter rule placed horizontally against the wall, with the participants barefooted. The weight was measured (in kilograms) with a weighing scale without shoes and with the patient wearing light clothing, to the nearest 0.1 kg.Waist circumference was measured to the nearest 0.5 cm above the iliac crests and below the lowest rib margin at minimal respiration in a standing position. Lung function test was performed in every participant by experienced technician using an automated flow-sensing spirometer based onAmerican Thoracic Society recommendations. Values used in the study were the forced vital capacity (FVC), FEV1 and FEV1-to-FVC ratio. The highest FVC and FEV1 value of the three or more tests with acceptable curves was usedin the analysis. Obstructive lung impairment was defined as an FEV1-to-FVC ratio less than 0.70 and an FVC more than equal to 80% of the predicted value. Restrictive lung impairment was defined as an FVC less than 80% of the predicted value and an FEV1-to-FVC ratio more than equal to 0.70. Mixed lung impairment was defined as a FEV1-to-FVC ratio less than 0.70 and FVC less than 80% of the predicted value. The other was defined as normal lung function.

Statistical Analysis

Statistical analysis was performed by the SPSS program for Windows, version 17.0. Continuous variables are presented as mean ± SD, and categorical variables are presented as absolute numbers and percentage. Data were checked for normality before statistical analysis. Normally distributed continuous variables were compared using the unpaired t test, whereas the Mann-Whitney U test was used for those variables that were not normally distributed. Categorical variables were analysed using either the chi square test or Fisher's exact test. One-way analysis of variance (ANOVA) was used to evaluate the significance of the differences in variables among normal, restrictive and mixed groups. If the F value was significant and variance was homogeneous, Tukey's multiple comparison test was used to assess the differences between the individual groups; otherwise, Tamhane's T2 test was used. The Kruskal-Wallis test was used to compare the three groups in terms of none normally distributed data. For all statistical tests, a p value less than 0.05 was taken to indicate a significant difference.

Observations and results

A. General characterstics:-

We have studied total 100 patients. Maximum patients had age between 41 to 60 years (48%) followed by age group of more than 60 years (41%). Among all patients, 51% were male and 49% were female.

Mean height of our study population was 160.28cm, mean weight was 74.24kg and mean weight circumference was 94.05.

66% patients were known hypertensive individual and were on regular medication. Rest 34% were not known hypertensive previously.

Mostly were non-smokers (69%). 25% were formal smoker and 6% were only current smokers.

93% were non-alcoholic among all subjects. 7% were alcoholic.

98% patients had mild and 2% patients had moderate physical activity. No subject had history of vigorous physical activity.

Mean triglyceride level was 128.78 . Mean HDL level was 39.39. Mean value of FEV1/FVC was 84.29. Mean value of FVC was 65.78.

We found most of the patients obese [BMI≥30] and they were [26+9+8=43%].

B. Pulmonary function test results in subjects of metabolic syndrome:-

Among all these 100 subjects, 58% had restrictive and 8% had mixed changes. No isolated obstructive change was noted among all these patients.

Pulmonary function became abnormal with increasing age of patients mostly mixed pulmonary defect. However, restrictive lung function was also noted with increasing age, but it is comparable to patients with normal lung function. But the mean height and weight values were comparable between patients of normal and impaired lung function (table-1).

Table 1: Comparison of Pulmonary function according to age, height and weight-

	Normal (n=34)	Abnormal			P values			
		Total (n=66)	Restrictive (n=58)	Mixed (n=8)				
	Mean ± SD		Mean ± SD	Mean ± SD	Normal vs Abnormal	Normal vs Restrictive	Normal vs Mixed	Restrictive vs Mixed
Age	53.53 ± 12.48	59.41 ± 14.11	58.64 ± 14.43	65.00 ± 10.61	0.043	0.194	0.048	0.430
Height(cm)	159.85 ± 11.69	160.50 ± 10.32	160.29 ± 10.66	162.00 ± 7.23	0.777	0.981	0.870	0.909
Weight(kg)	72.24 ± 15.06	75.27 ±20.93	74.28 ± 21.01	82.50 ± 20.13	0.454	0.874	0.363	0.492

[Abnormal means- 'Number of total 'Abnormal PFTs'-which consists of summation of subjects with obstructive, restrictive and mixed changes]

Patients whether alcoholic or non alcoholic had no much statistical significance on lung function as p value were not found to be much significant (table-2).

Table 12: Comparison of Pulmonary function according to alcohol status-

Alcohol	Normal (n=34)	Abnormal			P values			
		Total (n=66)	Restrictive (n=58)	Mixed (n=8)				
	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	Normal vs Abnormal	Normal vs Restrictive	Normal vs Mixed	Restrictive vs Mixed
No	32 (94.1%)	21 (31.8%)	53 (91.4%)	8 (100%)	0.805	1.000	1.000	1.000
Yes	2 (5.9%)	45 (68.2%)	5 (8.6%)	0 (0.0%)				
Total	34 (100%)	66 (100%)	58 (100%)	8 (100%)				

Mean FVC value of patients having restrictive changes were 53.57. In normal patients, mean FVC was 90.06. Statistically the value was significant (table-3).

Table 13: Comparison of FEV1/FVC and FVC values in normal and abnormal PFT-

	Normal (n=34)	Abnormal			P values			
		Total (n=66)	Restrictive (n=58)	Mixed (n=8)				
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Normal vs Abnormal	Normal vs Restrictive	Normal vs Mixed	Restrictive vs Mixed
FEV1/FVC	87.65 ± 15.05	82.56 ± 13.53	85.78 ± 10.74	59.25 ± 7.27	0.090	0.758	<0.001	<0.001
FVC	90.06 ± 16.03	53.27 ± 15.26	53.57 ± 15.92	51.12 ± 9.60	<0.001	<0.001	<0.001	0.909

[Abnormal means- 'Number of total 'Abnormal PFTs'-which consists of summation of subjects with obstructive, restrictive and mixed changes]

Patients having normal lung function had mean BMI of 28.5. Mean BMI of patients with abnormal lung function was 29.3. So, normal or impaired lung function was independent of obesity (table-4).

Table 4: Comparison of BMI and PFT-

	Normal (n=34)	Abnormal			P values			
		Total (n=66)	Restrictive (n=58)	Mixed (n=8)				
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Normal vs Abnormal	Normal vs Restrictive	Normal vs Mixed	Restrictive vs Mixed
BMI	28.50 ± 6.79	29.30 ± 8.19	28.97 ± 8.28	31.68 ± 7.60	0.627	0.958	0.552	0.626

We found no association between FEV1/FVC ratio and FVC value with BMI as p value was not found to be significant (table-5).

Table 5: Comparison of BMI with FVC and FEV1/FVC value-

	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	P Value
	<18.5	18.5 - 24.9	25 - 29.9	30 - 34.9	35 - 39.9	>=40	
FEV1/FVC	91.33 ± 19.86	85.38 ± 15.38	84.56 ± 16.17	84.54 ± 12.54	80.89 ± 4.81	79.88 ± 15.61	0.826
FVC	36.67 ± 15.28	69.86 ± 23.91	67.36 ± 24.80	64.77 ± 19.24	66.11 ± 24.63	59.88 ± 27.36	0.287

We did not found any association between impaired lung function with BMI (table-6).

Table 16: Comparison of BMI with normal and abnormal lung function (Obstructive, restrictive and mixed)-

Pattern	BMI						P Value
	<18.5	18.5 - 24.9	25 - 29.9	30 - 34.9	35 - 39.9	>=40	
	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	
Normal	0 (0%)	10 (34.5%)	10 (40.0%)	9 (34.6%)	4 (44.4%)	1 (12.5%)	0.510
Restrictive	3 (100%)	18 (62.1%)	12 (48.0%)	15 (57.7%)	5 (55.6%)	5 (62.5%)	
Mixed	0 (0%)	1 (3.4%)	3 (12.0%)	2 (7.7%)	0 (0%)	2 (25.0%)	
Total	3 (100%)	29 (100%)	25 (100%)	26 (100%)	9 (100%)	8 (100%)	

Most patients were never smokers. We did not find any association between smoking and impaired lung function as p value was not found to be significant (table-7).

Table 7: Comparison of smoking and PFT-

Smoking	Normal (n=34)	Abnormal			P values			
		Total (n=66)	Restrictive (n=58)	Mixed (n=8)				
	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	Normal vs Abnormal	Normal vs Restrictive	Normal vs Mixed	Restrictive vs Mixed
Never	24 (70.6%)	45 (68.2%)	42 (72.4%)	3 (37.5%)	0.805	0.851	0.110	0.098
Formal	8 (23.5%)	17 (25.8%)	13 (22.4%)	4 (50.0%)	0.807	0.902	0.195	0.189
Current	2 (5.9%)	4 (6.1%)	3 (5.2%)	1 (12.5%)	1.000	1.000	0.479	0.411

[Total abnormal means- 'Number of total 'Abnormal PFTs'-which consists of summation of subjects with obstructive, restrictive and mixed changes]

98 out of 100 patients had mild physical activity. So, level of physical activity had no significance on pulmonary function in our study (table-8).

Table 18: Comparison of physical activity and PFT-

Physical activity	Normal (n=34)	Abnormal			P values			
		Total (n=66)	Restrictive (n=58)	Mixed (n=8)				
	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	Normal vs Abnormal	Normal vs Restrictive	Normal vs Mixed	Restrictive vs Mixed
Mild	33 (97.1%)	65 (98.5%)	58 (100%)	7 (87.5%)	1.000	0.370	0.348	0.121
Moderate	1 (2.9%)	1 (1.5%)	0 (0.0%)	1 (12.5%)	1.000	0.370	0.348	0.121
Vigorous	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	-	-	-	-

Obesity of male and female did not affect pulmonary function as p value was not found to be significant (table-9).

Table 9: Comparison of Obesity and PFT (among males and females)-

	Normal (n=34)	Abnormal			P values			
		Total (n=66)	Restrictive (n=58)	Mixed (n=8)				
	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	Normal vs Abnormal	Normal vs Restrictive	Normal vs Mixed	Restrictive vs Mixed
Total								
Non obese	20 (58.8%)	37 (56.1%)	33 (56.9%)	4 (50.0%)	0.791	0.857	0.706	0.723
Obese	14 (41.2%)	29 (43.9%)	25 (43.1%)	4 (50.0%)				
Female								
Non obese	7 (41.2%)	16 (50.0%)	15 (50.0%)	1 (50.0%)	0.556	0.762	1.000	1.000
Obese	10 (58.8%)	16 (50.0%)	15 (50.0%)	1 (50.0%)				
Total	17 (100%)	32 (100%)	30 (100%)	2 (100%)				
Male								
Non obese	13 (76.5%)	21 (61.8%)	18 (64.3%)	3 (50.0%)	0.358	0.513	0.319	0.653
Obese	4 (23.5%)	13 (38.2%)	10 (35.7%)	3 (50.0%)				
Total	17 (100%)	34 (100%)	28 (100%)	6 (100%)				

Normal or high waist circumference did not effect on pulmonary function among these patients as p value was not found to be significant (table-10).

Table 20: Comparison of waist circumference and PFT-

Waist cir.(cm)	Normal (n=34)	Abnormal			P values			
		Total (n=66)	Restrictive (n=58)	Mixed (n=8)				
	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	Normal vs Abnormal	Normal vs Restrictive	Normal vs Mixed	Restrictive vs Mixed
Normal	8 (23.5%)	13 (19.7%)	13 (22.4%)	0 (0.0%)	0.656	0.902	0.316	0.339
High	26 (76.5%)	53 (80.3%)	45 (77.6%)	8 (100%)				

Comparison between subjects on regular anti-hypertensive therapy and subjects without medication showed no effect on lung function (table-11).

Table 21: Comparison of subjects with regular antihypertensive therapy and PFT-

BP	Normal (n=34)	Abnormal			P values			
		Total (n=66)	Restrictive (n=58)	Mixed (n=8)				
	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	Normal vs Abnormal	Normal vs Restrictive	Normal vs Mixed	Restrictive vs Mixed
Not on t/t	10 (19.4%)	11 (16.7%)	10 (17.2%)	1 (12.5%)	0.138	0.172	0.657	1.000
On regular t/t	24 (70.6%)	55 (83.3%)	48 (82.8%)	7 (87.5%)				

Subjects with normal triglyceride level and high triglyceride level had no much association with pulmonary function abnormality (table-12).

Table 22: Comparison of subjects with Triglyceride level and PFT-

TG	Normal (n=34)	Abnormal			P values			
		Total (n=66)	Restrictive (n=58)	Mixed (n=8)				
	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	Normal vs Abnormal	Normal vs Restrictive	Normal vs Mixed	Restrictive vs Mixed
Normal	24 (170.6%)	46 (69.7%)	40 (69.0%)	6 (75.0%)	0.927	0.870	1.000	1.000
High	10 (29.4%)	20 (30.3%)	18 (31.0%)	2 (25.0%)				

Subjects with high HDL level and normal HDL level had not been found to have statistical significance (table-13).

Table 13: Comparison of subjects with HDL level and PFT-

HDL	Normal (n=34)	Abnormal			P values			
		Total (n=66)	Restrictive (n=58)	Mixed (n=8)				
	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	Normal vs Abnormal	Normal vs Restrictive	Normal vs Mixed	Restrictive vs Mixed
Normal	8 (23.5%)	11 (16.7%)	10 (17.2%)	1 (12.5%)	0.407	0.463	0.662	1.000
Low	26 (76.5%)	55 (83.3%)	48 (82.8%)	7 (87.5%)				

Impaired pulmonary function in metabolic syndrome was independent of sex (table-24).

Table 24: Comparison of subjects according to sex and PFT-

Sex	Normal (n=34)	Abnormal			P values			
		Total (n=66)	Restrictive (n=58)	Mixed (n=8)				
	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	Normal vs Abnormal	Normal vs Restrictive	Normal vs Mixed	Restrictive vs Mixed
Female	17 (50.0%)	32 (48.5%)	30 (51.7%)	2 (25.0%)	0.866	1.000	0.298	0.260
Male	17 (50.0%)	34 (51.5%)	28 (48.3%)	6 (75.0%)				

DISCUSSION

We used 2005 revised NCEP ATP III guideline as proposed by the AHA/NHLBI criteria to diagnose metabolic syndrome which was exclusively for Asian Men and Women. Wen-Yuan Lin et al7 diagnosed metabolic syndrome using NCEP criteria for one group of patients and AHA/NHLBI criteria for another group of patients. Nathalie Leone et al11 defined according to AHA/NHLBI and IDF statements. The diagnosis of metabolic syndrome for Kei Nakajima et al25 patients was based on the Adult Treatment Panel of the modified Third Report of the NCEP Expert Panel (ATP-III) criteria. They used another criteria also proposed by the International Diabetes Federation (IDF) and by the Japanese Society of Internal Medicine (JSIM).

Among all patients in our study, the results showed that 58% cases had restrictive changes on pulmonary function test, 8% had mixed defect, with rest 34% having normal pulmonary functions. Restrictive changes in pulmonary function were supported by study of Wen-Yuan et al7, Nathalie leone et al11, Kei Nakajima et al25, SooKyoungkim et al38, Fawn Yeh et al43. However we did not get any patient with pure obstructive pattern which was supported by Nathalie leoneet al11 and Fimognari FL et al16 study. Kei Nakajima et al25 study result also did not find significant obstructive pattern in metabolic syndrome patients which was comparable to our results. Mean FEVI/FVC value of our metabolic syndrome patients was 84.29 which was comparable with Soo Kyoung Kim et al38 study (value-82). But mean FVC value of our study (65.78) was lower compared to this study (value-93.1). In Fawn Yehet al43 study population, mean FEV1/FVC ratio was 76.3 which was lower than our study whereas FVC value was 94.5 which was higher compared to our subjects. Nathalie leone et al11 study individuals had FEV1/FVC mean value of 81.3 which was almost comparable to our study. They considered FVC lower limit of normal as an absolute value. But we and most of other studies had considered FVC as percentage which was not comparable to their study. Kei Nakajima et al25 study patients had FEV1/FVC ratio of 81.7 which was also comparable to our subjects. Mean FVC value in their patients were 94 which was much higher compared to our study individuals. So, restrictive lung function was more severe in our study population compared to these study groups.

We also noted that as the age of our study population increased progressively, the mixed defect of pulmonary function also increased. Low chest wall compliance and high peripheral airway resistance are the possible mechanisms for the abnormal lung function tests. Systemic inflammation produced by metabolic syndrome results the progression to abnormal lung function in a longitudinally followed cohort. It provides a better explanation about the mechanism of interaction and better comprehension of pathogenesis of airflow obstruction in patients with metabolic syndrome. Lung function impairment with increasing age was comparable with Lin et al study7. Mean age of population in their study was 37.3 years which was lower than our study population 57.41 years. Similarly in Nathalie Leone et al11 study, lung function impairment was associated with metabolic syndrome independent of the age. Mean age of their population was 45.7 years which was also lower than our study population. Discrepancy between these two results might be due to study in two different geographical regions. Further study is needed in future.

Smoking induces insulin resistance. It is known to be a risk factor for metabolic syndrome. Wen Yuan et al7 study showed that prevalence of metabolic syndrome was higher in current smokers. But we got metabolic syndrome patients mostly non smokers. Kei Nakajima et al25 study population had current smokers of 27.3% which was more in number compared to our population (6%). Their result showed that the decline of lung function in metabolic syndrome was independent of the smoking status of the population. The same thing was also suggested by our study results.

Moderate to vigorous physical activity is protective against the development of metabolic syndrome, diabetes and cardiovascular diseases. Higher number of patients in Wen Yuan et al7 study had mild physical activity which was similar to our study (98%). Nathalie leone et al11 also studied on individuals who had less physical activity. This thing was comparable to our study population.

Study by Wen Yuan et al7 and Nathalie leone et al11 study did not find association between alcohol drinking in metabolic syndrome and impaired lung function which was comparable to our study.

Our patients had mean BMI≥28. Patients of Soo Kyoung Kim et al38 had mean BMI of 24.1 kg/m2. Subjects of Wen-Yuan lin et al7 had mean BMI of 22.6 kg/m2 and patients of Nathalie leone et al11 had mean BMI of 25.1 kg/m2, all of which had lower than mean BMI value of our subjects. But our study result of impaired lung function independent of obesity in patients with metabolic syndrome was supported by their studies.

Metabolic syndrome was associated with lung function impairment irrespective of sex in our study. It was similar finding with Wen-Yuan Lin et al7 and Nathalie Leone et al11. Wen-Yuan Lin et al7 and Fawn

Yeh et al43 found the prevalence of metabolic syndrome was more in female subjects compared to male individuals. So, metabolic syndrome is becoming a common problem with increasing trend in the female also.

Conclusion:

Metabolic syndrome is one of the major health challenges all over the world. It is associated with impaired lung function; predominantly restrictive type.Low chest wall compliance is the possible mechanism for such impairment. Abnormal lung function is independently associated with sex, height, weight, waist circumference, BMI, antihypertensive medication, smoking, alcohol drinking, physical activity, HDL level, triglyceride level. As the age of such patients increase progressively, mixed pulmonary defect is found to be associated. Because, metabolic syndrome causes to develop insulin resistance which has been found to have mitogenic effects on the airway smooth muscle, induces a hypercontractile phenotype on these cells and increases peripheral resistance.Therefore, a lung function test may be useful noninvasive tool to evaluate such patients in a clinical setting.

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