



Review Article

## Correlation of Spirometric Indices with Metabolic Risk Factors in Apparently Healthy Adults

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### ABSTRACT

**Background & Aims:** Central obesity, hyperglycemia, hypertension, & dyslipidemia are the risk factors of metabolic syndrome and the treatment of each risk factor includes life style modification. Exercise is important and integral part of life style modification and is dependent on lung functions. So this study has been done to find the correlation between spirometric indices and metabolic risk factors in apparently healthy adults.

**Material and methods-** We have recruited apparently healthy adults (n= 120) and measured waist and hip circumference, blood pressure, HDL, LDL, triglycerides and FBS in all the subjects. Among those seventy-seven subjects were found to have at least one or more metabolic risk factors (case group) according to NCEP ATP III criteria (with waist circumference >90cm for male and >80cm for female) and forty-three were without any metabolic risk factors (control group). Thereafter, spirometry was done in all the recruited subjects in both the groups and compared spirometric indices in both the groups.

**Results:** Persons at metabolic risks (case group) were having their FVC (L), FVC (%), FEV1 (L) and FEV1 (% of predicted) statistically significant lower and FEV1/FVC (%) values statistically significantly higher in comparison to the persons without metabolic risk factors (controls) indicating restrictive pattern of spirometric indices in persons at metabolic risks. We found in the study that as the number of metabolic risk factors increases FVC and FEV1 decreases gradually whereas FEV1/FVC increases initially but later decreases. On applying Tukey Post-Hoc test for Effects of number of metabolic risk factors on spirometric indices we found statistically significant correlation between 1 vs 3 risk factors and spirometric indices (FVC% and FEV1%) and between 1 vs 4 risk factors and spirometric indices (FVC(L), FVC % and FEV1(L), FEV1%)

**Conclusion-** This study concluded that spirometric indices shows restrictive pattern in individuals having metabolic risk factors.

**Keywords:** metabolic risk factors, spirometric indices, FVC.

### INTRODUCTION

Diabetes, hypertension, central obesity & dyslipidemia, all are the risk factors of metabolic syndrome and when at least three or more factors are present simultaneously, the condition is termed as metabolic syndrome.[1] Metabolic syndrome and its factors have high prevalence in India [2,3] and must be addressed & managed promptly to prevent long term ill effects on the body organs.

When inflammation increases in lungs and its airway either due to intrinsic causes such as metabolic risk factors (MRF)[4] or extrinsic causes as exposure to external toxic fumes and pollutants [5,6],it will result in increased production of reactive oxygen species (ROS) by various inflammatory cells. These ROS are usually neutralized by antioxidant system of body but when ROS production is increased beyond the antioxidant system capacity, it ultimately results in lung damage and in turn altered lung functions which can be assessed and demonstrated by spirometric indices. When inflammation increases in lungs due to increased systemic inflammation caused by various intrinsic factors such as metabolic risk factors [7,8], increased lung damage will occur resulting in altered lung functions which can be demonstrated by spirometric indices.

Purpose of the present study is to see the correlation of metabolic risk factors and spirometric indices in apparently healthy adults.

Metabolic syndrome (MS) is a chronic life style disorder leading to various diseases. The US National Cholesterol Education Program Adult Treatment Panel III (2001) [9] defined MS as clinical condition with at least three of the followings-Central obesity (waist circumference  $\geq 102$  cm or 40 inches in male &  $\geq 88$  cm or 35 inches in female), Dyslipidemia (TG  $\geq 150$  mg/dl, HDL-C  $< 40$  mg/dl in male &  $< 50$  mg/dl in female), Blood pressure  $\geq 130/85$  mmHg (or treated for hypertension) and Fasting plasma glucose  $\geq 110$  mg/dl. Each of the criteria of MS is a metabolic risk factor for metabolic syndrome. In the present study, we followed National Cholesterol Education Program Adult Treatment Panel III (2001) criterion (with modified waist circumference criteria i.e.  $>90$ cm in male and  $>80$  cm in female) [10] to diagnose the cases at risk of MS.

Lungs are the elastic structures involved in respiration. Their function can be assessed by pattern of airflow by computerized spirometry. The spirometric parameters that are included in this study are Forced vital capacity (FVC), Forced expiratory volume in first second (FEV1) and FEV1/FVC ratio and analysis of air flow pattern was done based on above parameters.[11] So we assessed spirometric indices in both case and control group and studied the airflow pattern in both the groups.

Many studies have been done to assess lung functions in subjects with metabolic syndrome. Singh VP et al [12] found in their studies that metabolic syndrome is associated with asthma like changes in spirometry (obstructive pattern in spirometry). Earl S. Ford et al [13] concluded in their study that spirometry is more likely to show restrictive pattern among adults with metabolic syndrome and less likely to show obstructive pattern in spirometry. There are many other studies which shows either restrictive or obstructive spirometric pattern in their analysis. Thus, it seems that subjects with established metabolic syndrome may show both obstructive and restrictive pattern in spirometry. But no studies have been done to assess the lung function in early stages of metabolic risk factors. Therefore, this study has been planned to assess the spirometric indices in the apparently healthy adults with metabolic risk factors.

#### **MATERIAL AND METHOD-**

The proposed study has been conducted in the department of Physiology of KGMU, Lucknow after taking ethical clearance from Institutional Ethics Committee.

Apparently healthy adults both the gender i.e. male and female, of age in between 21 to 45 years, were enrolled for this study after getting their consent for the participation from the general population of Lucknow city. All the recruited subjects were subjected to personal, family and detailed medical history. Individuals with any diagnosed cardiac, endocrinal, inflammatory, oncological or with any other metabolic problems were excluded from the study. Individuals with any acute or chronic infections were also not included in the study. Pregnant females, post-menopausal females & females with any gynecological and obstetrical disorders were not recruited for the study.

All recruited subjects were subjected to anthropometric measurements i.e. waist circumference, Blood Pressure measurement, Serum Levels of HDL, Triglycerides, LDL & fasting blood sugar was measured in all the subjects. Pulmonary Function Test was done by computerized Spirometry [11] and Forced Vital Capacity, Forced Expiratory Volume in one second, FEV1/FVC Ratio was considered for the study.

After recruitment of the subjects on the basis of inclusion and exclusion criterion, all the subjects were screened for metabolic risk factors according to National Cholesterol Education Program Adult Treatment Panel III 2001 criteria. NCEP ATP III [9] defined MS as clinical condition with at least three of the followings- Central obesity (with modified waist circumference criteria i.e.  $>90$ cm in male and  $>80$  cm in females for Indian population[10]), Dyslipidemia (TG  $\geq 150$  mg/dl, HDL-C  $< 40$  mg/dl in male &  $< 50$  mg/dl in female), Blood pressure  $\geq 130/85$  mmHg (or treated for hypertension) and Fasting plasma glucose  $\geq 110$  mg/dl. Each of the criteria of MS is considered to be a metabolic risk factor for metabolic syndrome. Subjects with any one metabolic risk factors were kept in case group and subjects without any risk factors were kept in control group. All subjects in both the group were subjected to computerized spirometry and spirometric indices were compared in both groups to find the correlation between metabolic risk factors and spirometric indices.

#### **OBSERVATIONS & RESULTS-**

##### **Clinical characteristics of the study population**

The demographic profile of the study group included age, gender, weight, height, waist, BMI, SBP, DBP, TG, HDL, LDL and FBS among the controls and cases are shown in Tables 1. Values are expressed as mean  $\pm$  SD and percentage. p-values indicate results of independent samples t tests between controls and cases groups.

Both the cases and control groups were matched according to their age, sex and height. Weight, BMI, Waist circumference, Systolic BP, Diastolic BP, TG, LDL and Fasting blood sugar were statistically significantly raised in case group and HDL was statistically significantly raised in control group.

As shown in Table 2 and Figure 1 the mean FVC (L), FVC (% of predicted), FEV1 (L), FEV1 (% of predicted) of case group were found to be statistically significantly ( $p < 0.001$ ) lower than respective control groups. The mean of FEV1/FVC (%) of case group was found to be statistically significant higher ( $p = 0.05$ ) than controls. FEV1/FVC (L) of cases were found to be statistically non-significantly ( $p = 0.068$ ) higher.

Table 3 shows that the spirometric indices FEV1, FEV1%, FVC and FVC % all were found to decrease as number of metabolic risk factor were increasing whereas FEV1/ FVC and FEV1/ FVC (%) were not much affected by number of metabolic risk factors.

Table 4 shows statistically significant correlation between 1 vs 3 risk factors and spirometric indices (FVC% and FEV1%) and 1 vs 4 risk factors and spirometric indices FVC(L), FVC% and FEV1(L), FEV1%)

## DISCUSSION-

In the present study, 120 subjects were recruited and among them, seventy-seven who were having one or more metabolic risk factor (MRF) were put into case group and remaining subjects without any MRF were put into control group comprised of forty-three subjects. Both the groups were subjected to computerized spirometry.

We observed in this study that the mean FEV1/FVC (%) was lower in control group ( $99.05 \pm 7.29$ ) than case group ( $102.94 \pm 6.94$ ) and this difference was statistically significant ( $p = 0.005$ ). The mean of FEV1/FVC (L) of case group ( $0.84 \pm 0.05$ ) was higher than control group ( $0.82 \pm 0.06$ ) and there was no statistically significant difference between the two groups ( $p = 0.068$ ).

The mean FVC (L) was lower in case group ( $2.80 \pm 0.74$ ) than the control group ( $3.56 \pm 0.45$ ). Similarly, FVC (% of predicted) was also lower in case group ( $59.42 \pm 9.83$ ) than control group ( $73.91 \pm 3.82$ ). The difference in FVC (L) and FVC (% of predicted) between case and control group was statistically significant. These observations favor the restrictive pattern in spirometric indices in the case group.

FEV1 (L), FEV1 (% of predicted) of case group ( $2.36 \pm 0.66$ ,  $60.78 \pm 10.87$  respectively) were found to be statistically significantly ( $p < 0.001$ ) lower than control group ( $2.95 \pm 0.42$ ,  $72.85 \pm 5.69$ ). At first look, these observations are suggestive of obstructive pattern but looking at FEV1/FVC (L) and FVC (% of predicted) clears the picture.

The mean of FEV1/FVC (L) of cases ( $0.84 \pm 0.05$ ) and controls ( $0.82 \pm 0.06$ ) were almost similar and there was no statistically significant difference between the two groups ( $p = 0.068$ ). At the same time, the mean FVC (L) was statistically significantly lower in case group than control group. Thus, statistically significant decrease in FEV1 and FEV1 (%) in case group was secondary to decreased FVC in case group not due to any obstruction.

Various studies have been done to assess the lung functions in persons with metabolic risk factors. V P Singh et al [12] observed increased oxo-nitrate stress in subjects with metabolic syndrome. They also observed asthma like changes (obstructive change) in lung functions. Ford ES et al observed that restrictive pattern was more likely associated with subjects with metabolic syndrome compared with adults without Metabolic Syndrome. [13]

We observed restrictive pattern of spirometric change in case group comprised of subjects at metabolic risks. The probable explanation of this restrictive pattern is presence increased oxidative stress associated with metabolic risk factors and this increased oxidative stress leads to increased subtle inflammation [14,15] which damages the lungs. The lungs are elastic structures and damage due to inflammation will affect its elasticity adversely resulting in restrictive pattern. Higher the inflammation more will be lung damage resulting in more restrictive pattern in spirometric indices. Similar to the observation of our study, Kim CH et al [16] observed restrictive ventilatory dysfunction in prediabetics and Aparna et al [17] observed restrictive spirometric pattern in type 2 diabetics. Manmohan S. Biring et al observed a reduction in ERV, FVC, FEV1, FRC, FEF25–75%, and MVV in persons with morbid obesity. [18] AM Li observed Reduction in FRC and diffusion impairment were the common abnormalities found in the cohort of the obese subjects [19]. David Sparrow et al [20] observed that lower FVC was associated with increased risk of hypertension. Olof Birna Margretardottir [21] observed that hypertension and increased CRP were independently associated with impaired FEV1.

In this study, we also noticed that as the number of metabolic risk factors increases, spirometric indices also changed. As metabolic risk factors increase FEV1/ FVC, FEV1/ FVC (%) was not much altered but FVC (%) and FVC (L) both decrease gradually. At the same time FEV1 (L) and FEV1 (%) both decrease gradually as the number of metabolic risk factors increases. These observations again suggest increased restriction of lungs with increase in metabolic risk factors. The cause of increased restrictive pattern of spirometric indices may be attributed to gradual increase in oxidative stress (inflammation) due to increased metabolic risks. We found statistically significant correlation between 1 vs 3 risk factors and spirometric indices (FVC% and FEV1%) and 1 vs 4 risk factors and spirometric indices FVC (L), FVC% and FEV1(L), FEV1%). These observations suggest that forced vital capacity of the lung starts decreasing with the evolution of risk factors for metabolic syndrome and there was statistically significant decrease in FVC in case and control group. There is statistically significant difference in FVC (%) of subjects having one and two risk factors. As the MRFs increase FEV1 also decreases secondary to decrease in FVC suggestive of progression of restrictive pattern in spirometry indices.

These observations are important because functional status of lungs plays very important role in life style modifications that are suggested in all cases of metabolic syndrome. This study shows that lungs are affected early in the course of metabolic disease. Altered lung functions (decreased FVC) will restrict one's exercise capability resulting in early dyspnea while exercising and this will negatively affect the dedication of the patient for regular exercise which is very important component of life style modification. Assessment of lung functions at initial stages will help the physician to guide the patient to modify the intensity and type of the exercise according to lung function and this will definitely improve the compliance of the patient to the life style modification, the most important but most ignored part of the treatment of metabolic syndrome and related disorder.

### CONCLUSION-

In the present study, we observed altered spirometric indices in apparently healthy adults which were found to have metabolic risk factors and altered spirometric indices were suggestive of restrictive lung disease. Therefore, it is important to address lung functions at the earliest so that life style modifications can be done more efficiently as a preventive measure.

### Restriction of the study-

This study was done with a small sample size due to restriction of time and resources. A study with large sample size should be done to monitor lung functions in persons with metabolic risk factors and to assess the effect of individual metabolic risk factor on lung functions.

**Tables 1- Demographic Profile of the Study Group**

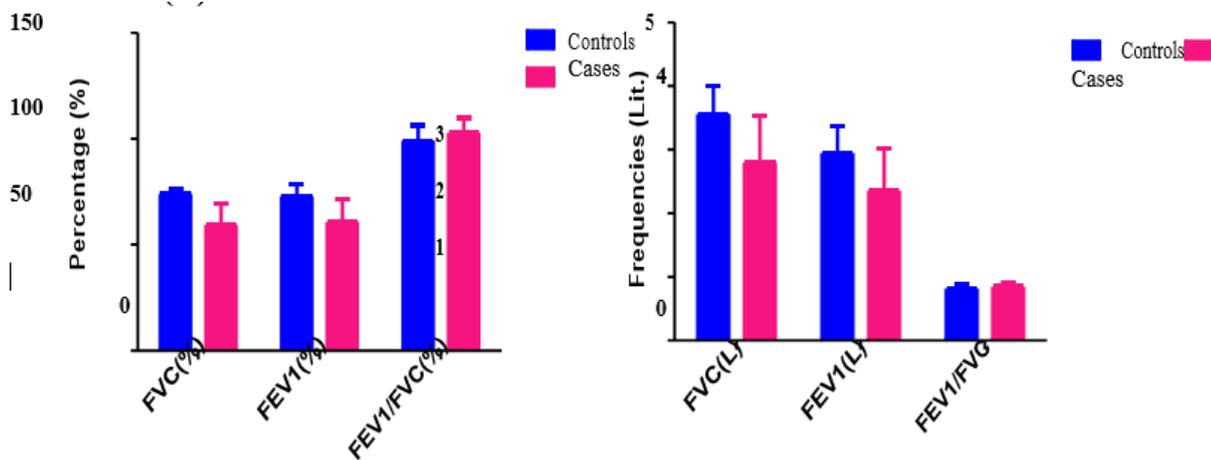
S. no	Parameters	Control(n=43)	Cases (n=77)	p-Value
1	Age (years)	34.05±5.49	35.67±5.76	0.134
2	Sex			0.136
	Male	32 (74.42%)	67 (87.01%)	
	Female	11 (25.58%)	10 (12.99%)	
3	Height	168.65±5.06	167.74±7.51	0.479
4	Weight (kg)	64.28±5.11	71.34±9.11	<0.001**
5	BMI (kg/m <sup>2</sup> )	22.55±0.91	25.31±2.40	<0.001
6	Waist (cm)	79.02±7.10	89.29±18.05	0.001**
7	SBP (mmHg)	118.05±7.55	134.78±13.33	<0.001**
8	DBP (mmHg)	78.23±4.96	86.13±13.49	<0.001**
9	TG (mg/dl)	102.35±21.95	152.77±38.85	<0.001**
10	HDL (mg/dl)	44.30±4.34	38.47±5.85	<0.001**
11	LDL (mg/dl)	111.40±15.49	151.19±30.36	<0.001**
12	FBS (mg/dl)	89.44±5.91	104.13±23.35	<0.001**

**Table 2: Comparison of Pulmonary function between groups**

	Control (n=43) Mean±SD	Cases (n=77) Mean±SD	p-Value
FVC (L)	3.56±0.45	2.80±0.74	<0.001**
FVC (%)	73.91±3.82	59.42±9.83	<0.001**
FEV1 (L)	2.95±0.42	2.36±0.66	<0.001**
FEV1 (%)	72.85±5.69	60.78±10.87	<0.001**
FEV1/FVC (L)	0.82±0.06	0.84±0.05	0.068
FEV1/FVC (%)	99.05±7.29	102.94±6.94	0.005*

\*\*= significant (p≤0.001), \*= significant (p≤0.05)

**Fig. 1: Distribution of pulmonary function a) FVC (L), FEV1 (L), FEV1/FVC and b) FVC (%), FEV1 (%), FEV1/FVC (%)**



**Table 3: Effects of number of metabolic risk factors and spirometric indices in metabolic risks patients**

	Numbers of metabolic risk factors				
	1 (n=28)	2 (n=28)	3 (n=13)	4 (n=8)	
FEV1 (L)	2.65±0.62	2.46±0.53	2.2062±0.20	1.27±0.59	<0.001**
FEV1 (%)	66.79±7.78	63.1071±5.77	56.3846±4.61	38.75±11.37	<0.001**
FVC (L)	3.16±0.69	2.84±0.56	2.73±0.29	1.56±0.73	<0.001**
FVC (%)	65.50±6.18	60.535±4.78	56.615±4.80	38.75±10.83	<0.001**
FEV1/ FVC	0.83±0.05	0.87±0.06	0.81±0.05	0.82±0.041	0.009*
FEV1/ FVC (%)	102.14±6.91	105.25±7.55	100.08±5.75	102.25±4.74	0.122

\*\*=significant (p≤0.001), \*= significant (p≤0.05)

**Table 4: Tukey Post-Hoc test for Effects of number of metabolic risk factors on level of GSH and hs-CRP and spirometric indices in metabolic risks patients**

	Numbers of metabolic risk factors		
	1 vs 2	1 vs 3	1 vs 4
FEV1 (L)	0.550	0.077*	<0.001**
FEV1 (%)	0.222	<0.001**	<0.001**
FVC (L)	0.202	0.160	<0.001**
FVC (%)	0.017*	<0.001**	<0.001**
FEV1/FVC	0.123	0.515	0.911
FEV1/FVC (%)	0.327	0.802	1.00

\*\*=significant (p≤0.001), \*= significant (p≤0.05)

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