Original Article

Prevalence of obstructive airway disease by spirometric indices in non-smoker subjects with IHD and HTN

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ABSTRACT

Background: Recent studies have found that there is a strong association between ischemic heart disease (IHD) and hypertension (HTN) with spirometric indices. **Aims:** To study the prevalence of obstructive airway disease (OAD) in non-smoker subjects with IHD and HTN and to compare them with healthy population. **Settings and Design:** This was a prospective, case–control, and observational study. **Subjects and Methods:** A total of 100 patients (cases) (*n* = 100) admitted in medicine department were recruited for this study. Controls (*n* = 100) were apparently healthy age- and sex-matched without HTN and IHD, recruited from March 2007 to July 2008. All eligible subjects were subjected to spirometric examination on a turbine-based spirometer (MIR spirolab-II) according to ATS/ERS guidelines. Forced expiratory volume/forced vital capacity (FEV_1/FVC) ratio <70% was used to make a diagnosis of OAD. **Statistical Analysis Used:** All analyses were carried out using Statistical Software Package for Social Sciences trial version (SPSS 10 version). **Results:** Out of 100 cases, 18 were with FEV_1/FVC ratio <70% (OAD) and 82 had >70% FEV_1/FVC ratio. Out of 100 controls, 2 were with FEV_1/FVC ratio <70% (OAD) and 98 had >70% FEV_1/FVC ratio. Eleven patients out of 66 from the case population with HTN had FEV_1/FVC ratio <70% (Odds ratio 8.044). Prevalence of OAD in the hypertensive individuals was 16.66%. Twelve patients out of 62 from the case population with IHD had FEV_1/FVC ratio <70% (Odds ratio of 9.333). Prevalence of OAD in the IHD individuals was 19.35%. In multiple correlation results for case population, when pulmonary function test variables were correlated with various dependant (age) and independent variables [HTN, IHD, height, weight, body mass index (BMI)], they were significantly reduced (P = 0.00017). In multivariate analysis (MANOVA), spirometric variables like FEV_1, FEV_1/FVC%, FVC, forced expiratory flow (FEF) 25–75%, and peak expiratory flow rate (PEFR) were compared with factors like IHD, HTN, and covariates like age and BMI. We found that systolic blood pressure (SBP; P = 0.005), diastolic blood pressure (DBP; P = 0.05), height (P = 0.05), weight (P = 0.042), and IHD (P = 0.0001) were strongly associated with reduced pulmonary functions like FEV_1, FEV_1/FVC%, and FVC. The presence of IHD and HTN were independently associated with the presence of OAD. **Conclusions:** This study highlights the increased prevalence of OAD amongst patients with IHD and HTN. Patients with IHD and HTN should routinely undergo inexpensive investigations like spirometry to detect the presence of underlying OAD.

KEY WORDS: Cardiovascular disease, comorbidities, COPD, FEV_1/FVC ratio, hypertension, IHD, OAD, spirometric indices

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INTRODUCTION

Obstructive airway diseases (OADs) primarily include asthma and chronic obstructive pulmonary disease (COPD), which are the major contributors to morbidity and mortality in India. Smoking, occupational exposures, and exposure to air pollutants are the major risk factors for the development of OADs. Although cigarette smoking is the major environmental risk factor for the development of COPD, only about 15% of smokers develop significant airflow obstruction. Recent studies have found that there is a strong association between ischemic heart disease (IHD) and hypertension (HTN) with increased prevalence of OAD. COPD is a debilitating disease. It is characterized by airflow limitation which is not fully reversible and progressive in nature. COPD is causing increasing health

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burden worldwide, and is the leading cause of death.[1,2] Reduced lung function is known to associated with increased all cause mortality. Regular measurement of lung functions can provide an important early clue to find out the people at high risk to a variety of diseases. The measurement of lung function by spirometry is one of the underutilized tools in the medical world.[3,4] The incidence of cardiovascular disease and death associated with HTN is increased among men with reduced lung function. Decline in the lung function, measured by FEV_1, is a predictor of mortality, independent of the other risk factors for cardiovascular disease. The natural course of COPD is complicated by the development of systemic consequences and co-morbidities. Importantly, although the prevalence of systemic consequences increases with increasing severity of airflow obstruction, both systemic consequences and co-morbidities are already present in the Global Initiative for Chronic Obstructive Lung Disease Stage II. This supports the concept of early intervention in COPD.[5,6] Thus, the use of spirometry in primary-care settings needs to focus on the most important aspects of lung function. So far, the prevalence of OAD in non-smoker subjects with IHD and HTN has been inadequately studied in India and overseas. This study was conducted to assess the prevalence of obstructive airway disease (OAD) in non-smoker subjects with IHD and HTN and to compare them with healthy population.

SUBJECTS AND METHODS

This was a case–control study comparing various lung function indices amongst the patients with IHD and/or HTN and apparently healthy control population. This study was conducted at Krishna Institute of Medical Sciences (KIMS), Karad. A total of 100 patients (cases) from the medicine Indoor Patient Department (IPD) of the KIMS were recruited in this study (n = 100). Controls (n = 100) were apparently healthy age- and sex-matched without HTN and IHD, recruited from IPD patients' relatives, not related to case population, from March 2007 to July 2008. Sample size for this prospective case–control study was calculated by sample size calculator and sampling spreadsheet Excel files by World Health Organization for chronic diseases and health promotion. Sample size was rounded up to 100 cases and 100 controls. The study protocol was approved by ethical committee of KIMS, Karad University, and written informed consent was obtained from all the participants.

AIMS AND OBJECTIVES

This study was conducted to assess the prevalence of obstructive airway disease (OAD) in nonsmoker subjects with IHD and HTN and to compare them with healthy population.

Subjects with known essential HTN or IHD or both were included as cases with age ≥35 and ≤65 years. Apparently healthy subjects without HTN and IHD were included in the control population. Subjects with known COPD or restrictive lung disease, with CCF (congestive cardiac failure), smokers, respiratory tract infection, and secondary HTN were excluded from this study. Smokers were excluded from the study to avoid the effect of smoking on spirometric indices as the risk factor for OAD and to study the role of IHD and HTN on spirometric indices unbiased. Exposure to ETS (Environmental Tobacco Smoke) is defined as the exposure of a nonsmoker to the combustion products of cigarettes and other tobacco products (exposure to secondhand smoke), and they were excluded on history basis.

Patients presenting to the KIMS at medicine IPD were recruited as cases. These patients were already diagnosed to have IHD and/or HTN and were on follow-up.

All the subjects were interviewed in detail for demographic information, vital statistics [height, weight body mass index (BMI)], disease history, smoking history, other addictions, family history, and symptoms. All the subjects underwent thorough general and systemic examination. Resting pulse rate and blood pressure were recorded. ECG findings were noted. Chest radiograph PA view was done. All the findings were recorded in a data entry sheet. Eligible subjects were subjected to spirometric examination on a turbine-based spirometer (MIR spirolab-II).

Spirometry was performed in accordance with American Thoracic Society guidelines for spirometry.[6,7] All the eligible subjects were asked to perform the spirometry maneuver. The best of three readings was obtained and saved.[6] Acceptability and repeatability criteria were applied. Fasting blood samples of all the subjects were collected and sent for hemoglobin (Hb), blood sugar level and lipid profile measurement, and other routine investigations.

Ischemic Heart Disease

IHD was defined as patients with known coronary artery disease provided either by history (personal history of CHD based on a positive rose chest pain questionnaire), two-dimensional echocardiogram (regional wall motion abnormality), and/or ECG (deep symmetric "T" wave inversion/"Q" in anterior, inferior leads, and diffuse ST-T changes).

Hypertension

HTN was defined as systolic blood pressure (SBP) ≥140 mmHg or diastolic blood pressure (DBP) ≥90 mmHg and reported use of antihypertensive medication in the 2 weeks prior to measurement. Three independent measurements of SBP and DBP were taken in the right arm using a manual standard mercury sphygmomanometer (diamond) under standard conditions as mentioned in cardiovascular survey methods after a 10-min rest, and the average of the last two measurements was used for the statistical analyses.

Height, Weight, and BMI

Height was measured to the nearest centimeter with the use of a standard right-angle device. Weight was measured with a spring balance. The participants wore typical indoor clothing without shoes. The BMI was defined as weight/height^2 (kg/m^2). Each subject's BMI was computed as weight (in kilograms) divided by height (in meters) squared.[8]

Lung Function Measurements

The diagnosis of COPD was confirmed by spirometry, a test that measures breathing. Spirometry measures the FEV_1, which is the greatest volume of air that can be breathed out in the first second of a large breath. Spirometry also measures the FVC, which is the greatest volume of air that can be breathed out in a whole large breath. Normally at least 70% of the FVC comes out in the first second (i.e. the FEV_1/FVC ratio is >70%). In COPD, this ratio is less than normal (i.e. FEV_1/FVC ratio is <70%) even after a bronchodilator medication has been given. Pulmonary function tests were performed with a spirometry on a turbine-based spirometer (MIR spirolab-II) according to American Thoracic Society (ATS) / European Respiratory Society (ERS) guidelines. FEV_1/FVC <70% was used to make a diagnosis of OAD. The tests were performed with the subject in a sitting position and with nose clips in place. Each subject performed at least five spirometric tests (with at least three reproducible and acceptable maneuvers). Reproducibility was considered as present when the second highest values of FEV_1 and FVC were within 5% of the highest values. The highest measured value of FEV_1 and the corresponding measured value of FVC were coded for computer analysis.[6] We defined spirometrically determined categories of airflow as follows: normal (FEV_1 and FVC above 80% predicted: FEV_1/FVC ratio above 0.7); mild airflow obstruction (FEV_1/FVC ratio <70% predicted; FEV_1 80% predicted); or airway obstruction (FEV_1/FVC ratio <70% predicted; FEV_1 <80% predicted) according to the Global Initiative for Chronic Obstructive.[6,7]

Statistical Methods

For both case and control population, lung function was expressed as absolute values (FEV and FVC) and height standardized values (FEV_1/Ht^2 and FVC/Ht^2); the latter were computed as (observed − predicted/standard deviation), where the predicted values were based on multiple linear regression models using age and height. For the case control analyses, we used Pearson correlation coefficients to examine the relationship between each lung function measures and both SBP and DBP and other dependant and independent variables. Partial correlation coefficients adjusting for age were also computed. For the longitudinal analyses, confidence intervals (95% CI) for the relative risk (RR) estimates were calculated using the Taylor Series Approximation method, and logistic regression analysis was employed to model the odds of developing incident HTN. All analyses were carried out by Statistical Software Package for Social Sciences trial version (SPSS 10 version). Unless otherwise stated, all *P* values are two-sided and the term "significant" means $P < 0.05$.

RESULTS

In the present study, a total of 100 subjects were cases, which included subjects with HTN and/or IHD. Out of the 100 cases, 29 were with IHD and HTN, 39 were with HTN, and 34 were with IHD. Sixty-six subjects were with HTN and 62 were with IHD [Table 1]. In case population, 59 were males (IHD and HTN: 17; HTN: 20; IHD: 22) and 41 were females (IHD and HTN: 12; HTN: 17 IHD: 12). In the control group, 55 were males and 45 were females. Amongst the male cases, 37 were with HTN and 39 were with IHD. Amongst the female cases, 29 were with HTN and 24 were with IHD [Table 2].

Descriptive statistical analysis for case group showed the following mean values: age, 53.24 years; SBP, 157; DBP, 90.74; FEV_1, 1.531; FVC, 1.897; FEV_1/FVC ratio %, 80.95; forced expiratory flow (FEF) 25–75, 1.684; peak expiratory flow rate (PEFR), 3.6; and BMI, 22.71 kg/m^2. Descriptive statistical analysis for control group showed the following mean values: age, 45.82 years; SBP, 119.62; DBP, 79.66; FEV_1, 2.42; FVC, 2.78; FEV_1/FVC ratio %, 87.62; FEF 25–75, 3.05; PEFR, 6.4; BMI, 21.82 kg/m^2. Totally 100 patients (cases) with diagnosed IHD and/or HTN (mean age 53.24 years, SD ± 11.037; FEV_1/FVC % 80.956, SD ± 14.366) and 100 healthy subjects (mean age 45.82 years, SD ± 8.390; FEV_1/FVC % 87.623, SD ± 7.219) were recruited in this study [Table 3].

Comparing both case and control group populations, the mean values of all spirometric variables were significantly low in the case group and other dependant variables like SBP, DBP, and BMI were significantly high ($P = 0.005$). In multiple correlation analysis, various spirometric parameters (FEV_1, FEV_1/FVC %, FVC, FEF 25–75, and PEFR) were correlated with independent variables like age, SBP, DBP, IHD, height, weight, and BMI in the case group; they were significantly reduced with $P = 0.005$. All spirometric variables were negatively correlated with age, HTN (SBP, DBP), IHD, weight, and BMI. Spirometric variables were significantly low in subjects with IHD and HTN compared to the control group.

Table 1: Distribution of hypertension and IHD in case population

Final diagnosis	Total (*n* = 100)	Percentage
IHD, HTN	29	29
IHD	34	34
HTN	37	37

IHD: Ischemic heart disease, HTN: Hypertension

Table 2: Gender wise distribution of case and control population

Male cases	59	Female cases	41	Control females	Control males
IHD, HTN	17	IHD, HTN	12	45	55
IHD	22	IHD	12	Nil	Nil
HTN	20	HTN	17	Nil	Nil

IHD: Ischemic heart disease, HTN: Hypertension

Table 3: Mean and standard deviation of numerical variable of case and control population

	AGE	SBP	DBP	FEV_1	FVC	FEV_1/FVC (%)	FEF 25–75	PEFR	HT	WT	BMI
Mean	53.24	157.5	90.74	1.531	1.897	80.956	1.684	3.6	160.8	61.86	22.711
Std. Dev.	±11.03	±23.64	±9.48	±0.581	±0.642	±14.36	±0.92	±1.73	±8.78	±52.97	±3.467
Mean	45.82	119.62	79.66	2.427	2.781	87.623	3.058	6.4	164.0	61.56	21.82
Std. Dev.	±8.39	±7.82	±5.07	±0.481	±0.57	±7.219	±0.87	±1.92	±9.42	±11.51	±3.38

SBP = systolic blood pressure, DBP = diastolic blood pressure, FEV_1 = forced expiratory volume in the first second, FVC = forced vital capacity, FEF = forced expiratory flow, PEFR = peak expiratory flow rate, HT = height, WT = weight, BMI = body mass index

In univariate analysis (ANOVA), low FEV_1 was significantly associated with high DBP (P = 0.038), low height (P = 0.00016), HTN, and IHD (P value of 0.008). Low FEV_1/FVC % was significantly associated with advancing age, i.e. elderly population (P = 0.007), high SBP (P value of 0.050), high DBP (P value of 0.036), increased weight (P value of 0.008), and HTN, IHD, and diabetes mellitus (DM) (P = 0.034). Low FVC was significantly associated with height (P value of 0.0001), HTN, and IHD (P value of 0.050). Low PEFR was significantly associated with height (P value of 0.010), HTN, and IHD (P = 0.010). FEF was not statistically associated with any of the dependent variables. In the present study, 18 subjects from the case population (IHD and/or HTN) had FEV_1/FVC % ratio ≤70% and 82 had >70%. In the control population, 2 subjects had FEV_1/FVC % ratio ≤70% and 98 subjects had >70% (P = 0.000162441). In multivariate analysis (MANOVA), spirometric variables like FEV_1, FEV_1/FVC %, FVC, FEF 25–75, and PEFR were compared with factors like IHD and HTN, and covariates like age SBP DBP, Ht, weight, and BMI. We found that SBP (P = 0.005), DBP (P = 0.05), height (P = 0.05), weight (P = 0.042), IHD, and HTN (P = 0.0001) were strongly associated with reduced pulmonary functions like FEV_1, FEV_1/FVC %, FVC, FEF 25–75, and PEFR [Figures 1 and 2].

In Pearson correlations analysis, spirometric variable of pulmonary function test (FEV_1/FVC ratio) was negatively correlated with IHD, HTN (−0.201), age (−0.339), SBP (−0.124), DBP (−0.150), BMI (−0.012), and height (−0.172) [Figure 1]. The maximum regression coefficient was seen with IHD, HTN (P = 0.032), age (P = 0.0001), height (P = 0.049), and weight (P = 0.012) [Figure 2]. In multivariate "t"-test, the results for paired datasets of pulmonary function test (FEV_1, FEV_1/FVC %, FVC, FEF 25–75, PEFR) in controls and cases showed that the reduction in FEV_1, FEV_1/FVC %, FVC, FEF 25–75, and PEFR in the case population was significant compared to the control population, with P = 0.0001. In "t"-test, the results for paired datasets of pulmonary function test (FEV_1/FVC %) in controls and cases showed that the reduction in FEV_1/FVC % in the case population was significant compared to the control population, with P = 0.00017. In multivariate analysis pulmonary function test variables were statistically significantly reduced when correlated with various dependant (age) and independent variables (SBP, DBP, HTN, DM, IHD, height, weight, BMI). (P < 0.001)

Odds Ratio for FEV_1/FVC Ratio <70% in Case Versus Control Population

Totally 18 subjects were with FEV_1/FVC ratio <70% and 82 had >70% FEV_1/FVC ratio in the case population. Two subjects were with FEV_1/FVC ratio <70% and 98 had >70% FEV_1/FVC ratio in the control population. Eleven subjects from the case population with HTN had FEV_1/FVC ratio <70% out of 66 [Odds ratio 8.044 (P = 0.002) and RR of 1.37]. Prevalence of OAD in hypertensive individuals was 16.66%. Twelve subjects from the case population with IHD had FEV_1/FVC ratio <70% out of 62 [Odds ratio of 9.333 (P = 0.001) and RR of 1.395]. Prevalence of OAD in IHD individuals was 19.35% [Table 4 and Figure 3].

Relation of Age to FEV_1/FVC Ratio in Patients with HTN and IHD

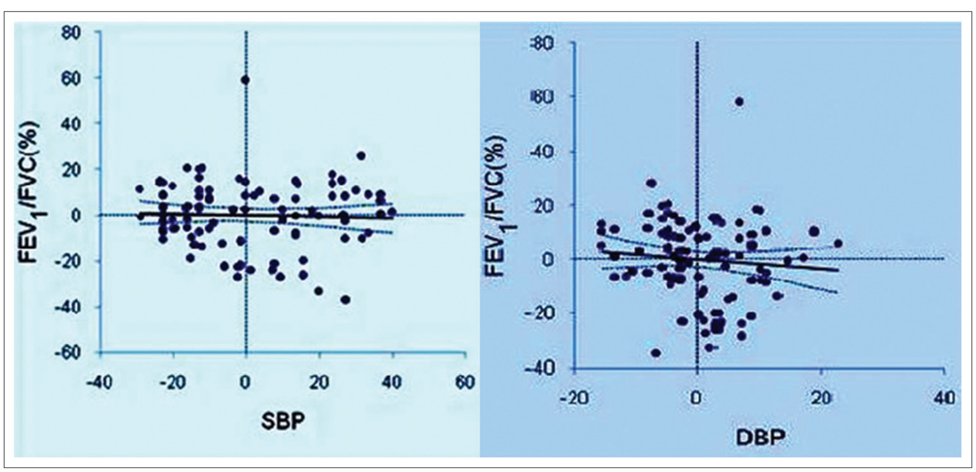

Figure 1: Correlation of spirometric variable (FEV_1/FVC ratio) with systolic and diastolic blood pressure

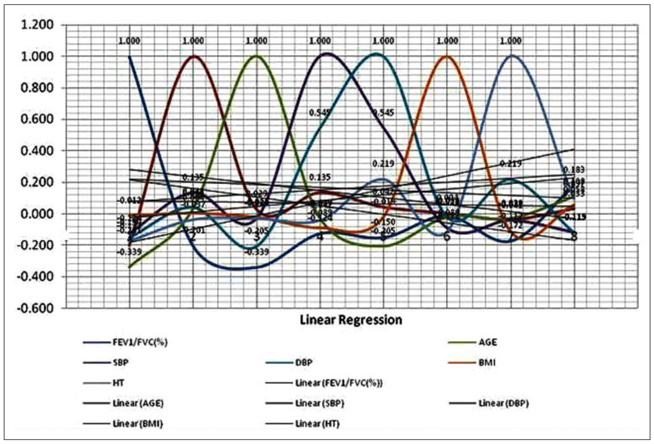

Figure 2: Multiple linear regression analysis of spirometric variable (FEV_1/FVC ratio) with age, SBP, DBP, height, and BMI

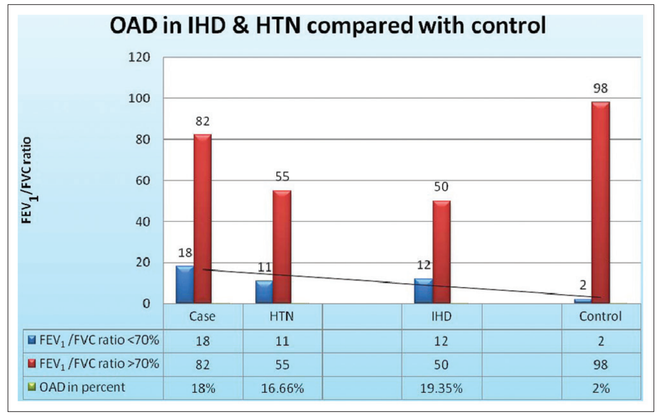

Figure 3: Prevalence of OAD in IHD and HTN compared to control population

Table 4: Odds ratio comparing cases and controls in patient with hypertension and IHD

	FEV_1/FVC ratio <70%	FEV_1/FVC ratio >70%	OAD in percent	Odds ratio
Case	18	82	18	
HTN	11	55	16.66	8.044 ($P = 0.002$) RR = 1.37
IHD	12	50	19.35	9.33 ($P = 0.001$) RR = 1.39
Control	2	98	2	

IHD: Ischemic heart disease, HTN: Hypertension

Five patients of age <45 years had FEV_1/FVC ratio <70% and six patients of age ≥45 years had FEV_1/FVC ratio <70% in the HTN population, which was statistically not significant. Five patients of age <45 years had FEV_1/FVC ratio <70% and seven patients of age ≥45 years had FEV_1/FVC ratio <70% in the IHD population, which was statistically not significant [Table 5].

DISCUSSION

Recent studies have shown a strong association of spirometric indices (FEV_1, FEV_1/FVC % ratio) with HTN and IHD. The subjects with HTN and IHD have increased prevalence of OAD. The aim of this study was to determine the prevalence of OAD in patients diagnosed with IHD and HTN, and compare that with the prevalence of OAD in healthy population. Very few studies have been conducted in India and overseas as well, in which spirometric variables were studied in patients with IHD and HTN.

In the present study, totally 66 subjects were with HTN and 62 were with IHD. Twenty-nine subjects were with concurrent two diseases, and 71 subjects were having single disease, i.e. either HTN or IHD. Spirometric variables were significantly low in subjects with IHD and/or HTN ($P = 0.005$). In multivariate analysis (MANOVA), SBP ($P = 0.005$), DBP ($P = 0.05$), height ($P = 0.05$), weight ($P = 0.042$), and IHD were strongly associated with reduced pulmonary functions (low FEV_1/FVC %). Eleven subjects out of 66 patients from the case population with HTN had FEV_1/FVC ratio <70%. Twelve subjects out of 62 patients from the case population with IHD had FEV_1/FVC ratio <70%. In the present study, 18% subjects from the case population had FEV_1/FVC% ≤70%, and in the control population, 2% subjects had FEV_1/FVC% ≤70. Patients with HTN and IHD were having significantly low FEV_1/FVC %.

We compared our results with various other studies. Engstrom *et al.*[9] in their study population of 467 hypertensive men found that the FEV_1 below median had significantly higher rates of cardiac events. The incidence of cardiovascular disease associated with HTN is increased among men with reduced lung function. These findings are comparable with present study in which by Pearson correlations linear regression, spirometric variables of pulmonary function test (FEV_1/FVC ratio) were negatively correlated with IHD (−0.201), age (−0.339), SBP (−0.124), and DBP (−0.150). In the study of Das *et al.*[10] on 86 (males 65, females 21) IHD patients, 51.2% ($n = 44$) patients had COPD, and according to GOLD criteria, 90.9% of cases of COPD had moderate to severe disease. They stated that the prevalence of COPD among IHD cases was higher than in the general population. Most of the COPD cases (81.8%) of IHD were newly detected in this study by spirometric evaluation.

Similarly, patients with IHD in the present study were not previously diagnosed as OAD and not on medications for the same. The prevalence of OAD in the present study was 19.35% (12/62). Margretardottir *et al.*[11] studied the interrelationship between airflow obstruction, smoking, HTN, obesity, and CRP as a marker of systemic inflammation ($N = 939$). They stated that HTN, BMI, and systemic inflammation affect lung function independently. All three variables have a negative effect on FVC, while HTN and high CRP are independently associated with impaired FEV_1. These findings are similar to the findings of the present study population with IHD and or HTN, with a prevalence of 18% OAD. Majumdar *et al.*[12] in their study found that 39 male and 21 female patients were diagnosed to have COPD. Hypertensives (21 males and 7

Table 5: Relation of age to FEV_1/FVC ratio in patients with HTN and IHD

Variables	<45 years	≥45 years
HTN with FEV_1/FVC ratio <70%	5 (45.45%)	6 (54.54%)
IHD with FEV_1/FVC ratio <70%	5 (41.66%)	7 (58.33%)
Statistically not significant		

IHD: Ischemic heart disease, HTN: Hypertension

females) showed obstructive spirometric pattern. In IHD patients (n = 6), FEV_1 % predicted showed significant reduction in spirometry. These findings are comparable with those of our study. Lainscak *et al.*[13] in their study on total of 638 patients with a discharge diagnosis of heart failure found that COPD was diagnosed in 106 (17%) patients and concluded that the COPD is frequent among hospitalized patients with heart failure. Similarly, in the present study, 13 patients out of 62 patients with IHD had signs and symptoms suggestive of heart failure, of which 8 had spirometric evidence of OAD.

Wu *et al.*[14] in in their study on 6757 Chinese men and women, aged 35–54 years, from Beijing and Guangzhou, China, found that lung function (FVC, FEV_1) varied inversely with baseline SBP and DBP in all women and in Beijing men. These findings are similar to our results wherein Pearson correlations linear regression showed that spirometric variables of pulmonary function test (FEV_1/FVC %) were negatively correlated with IHD (−0.201), age (−0.339), SBP (20.124), DBP (−0.150), and BMI (−0.012).

Holger *et al.*[15] in their sample of 554 men and 641 women, aged 20–89 years, from the city of Buffalo, found that reduced pulmonary functions were associated with IHD in both genders and could be used as a tool in general health assessment. Griffith *et al.*[16] stated that the subjects reporting congestive heart failure (CHF) and high SBP (>160 mmHg) had significantly lower spirometry levels.

Dhungel *et al.*[17] in their retrospective study of 237 COPD patients found that, the prevalence of COPD in patients with HTN was 41.3%, which was significantly higher compared to the normal population. These findings are similar to our results.

Kozlova *et al.*[18] studied the acquired COPD in patients with IHD and stated that the IHD patients taking drugs need monitoring of external respiration function (ERF). Optimal treatment consists in early diagnosis of IHD and COPD, and adequate combined therapy with beta-blockers and bronchodilating drugs. These findings are comparable to our study. Engström *et al.*[19] stated that moderately reduced FEV_1 and FVC were associated with an increased incidence of hospitalization due to HF. In multiple correlation results for the case population, pulmonary function test variables were significantly, positively correlated with height and negatively correlated with weight, age, BMI and blood pressure. (P = 0.00017).

Singh *et al.*[20] in their study found that age-associated significant decline in pulmonary function is more with HTN, DM, coronary artery disease, and BMI. These findings are similar to our study, in which pulmonary function test variables were statistically significant (P = 0.00017) and positively correlated with height and negatively correlated with weight, age, BMI, and blood pressure.

Engstrom *et al.*[2] in their study of 375 men found that lung function was inversely associated with future blood pressure increase. Similarly, in our study, SBP (−0.124) and DBP (−0.150) correlated negatively with spirometric variables. Engstrom *et al.*[9] in their cohort of 639 subjects found that hypertensive men with FEV_1 below median had significantly higher rates of stroke than hypertensive men with high FEV_1. The above findings are comparable to those of our study.

Rubinsztajn *et al.*[21] analyzed 266 records of patients who had diagnosis of COPD and died during hospitalization. They found that most the frequent disease coexisting with COPD was cardiovascular disease. Similarly, in our study, HTN and IHD were associated with reduction in FEV_1. Díez *et al.*[22] stated the most frequently associated co-morbidities with COPD are HTN, DM, infections, cancer, and cardiovascular diseases. Although not precisely known, the common mechanism of all these co-morbidities could be systemic inflammation and its mediators, which play an important role in the pathogenesis of COPD. Similarly, in the present study, we found that reduced pulmonary function tests were associated with IHD and HTN independent of age, gender, and duration, compared to the control population. Mascarenhas *et al.*[23] stated that progressively, more attention has been given to the interplay between COPD and heart failure. The combination is frequent, but largely unrecognized due to overlapping clinical manifestations. Patients presenting with both conditions seem to have an ominous course. Despite the overwhelming evidence supporting cardio-selective beta-blockade safety and tolerability in COPD patients, beta-blockers are underprescribed to heart failure patients with concomitant COPD.

Limitations

This study was conducted at a single centre. The concept in the article is new, and not enough literature is available in India and overseas. The sample size taken in the present study is small.

CONCLUSIONS

This study highlights a significant burden of OAD amongst patients with IHD and HTN. Patients with IHD and HTN should routinely undergo inexpensive investigations like spirometry to detect the presence of underlying OAD. In the present study, prevalence of OAD was 18% amongst the case population. 2% subjects from the control population had OAD. Prevalence of OAD in hypertensive individuals was 16.66%. Prevalence of OAD in IHD individuals was 19.35%. In patients with HTN and IHD, their combination had significantly low FEV_1/FVC %. Comparing both case and control populations, the mean values of all spirometric variables were significantly low in the case group and other dependant variables like SBP, DBP, and BMI were significantly high. All spirometric variables were negatively correlated with age, SBP, DBP, IHD, weight, and BMI. Lung function was inversely associated with increase in blood pressure. Given the importance of reduced FEV_1 in cardiovascular risk, it should be used in conjunction with existing risk markers such as blood pressure and serum cholesterol to assess risk and target preventive treatment. There is a significant association of IHD and HTN with FEV_1 and FEV_1/FVC %. Many population-based studies are required to evaluate the relationship between reduced spirometric variables and IHD and HTN. It is important to reinforce the importance of asymptomatic airflow obstruction and its association with increased morbidity and mortality. OAD should be regarded as an indolent disease process that only produces symptoms when a considerable loss of lung function has occurred. Effective management of OAD may reduce the cardiovascular morbidity and mortality in patients with HTN and IHD.

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