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Screening for Chronic Obstructive Pulmonary Disease in Patients with Coronary Artery Disease at a Tertiary Care Hospital

Malasree Jujjavarapu, Meenakshi Narasimhan*, Sridhar Rathinam and Shahana Balasubramanian

Department of Respiratory Medicine, Chettinad Hospital and Research Institute, Chettinad Academy of Research and Education, Kelambakkam-603103, Tamil Nadu, India

E-mail/Orcid Id:

MJ, malasreej96@gmail.com, https://orcid.org/0009-0007-4465-8815; *MN,* paddy_2020@yahoo.com, https://orcid.org/0000-0002-8743-149X; *SR,* srihema.1964@gmail.com, https://orcid.org/0000-0001-7661-2351; *SB,* drshahana93@gmail.com, https://orcid.org/0009-0001-8753-4413

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Abstract: Chronic Obstructive Pulmonary Disease is a common, preventable and treatable disease that is characterized by persistent respiratory symptoms and airflow limitation that is due to airway and/or alveolar abnormalities usually caused by significant exposure to noxious gases or particles and influenced by host factors, including abnormal lung development. COPD was the 4th most common cause of death globally, and it was anticipated to rise to the 3rd position by 2020 or sooner. Over 80% of these patients go undiagnosed. COPD and CAD frequently co-exist and interact due to various reasons like similar risk factors and pathogenesis. Although there are global studies on the prevalence of COPD in CAD patients, data from India are scarce. This study aims to find the prevalence of COPD among CAD patients and find the correlation between the occurrence of COPD and cardiac status. This study was conducted as a prospective observational cross-sectional study at Chettinad Hospital and Research Institute in India. 293 patients with angiographically proven CAD underwent pulmonary function evaluation by spirometry to assess the prevalence of COPD. Recent 2D-ECHO was also correlated. The study found that 18.77% of 293 Coronary Artery Disease (CAD) patients had COPD and 3.07% had PRISM(preserved ratio impaired spirometry, a new term coined), making it one of the few studies to report the prevalence of PRISM among CAD patients. Outside of India, studies have found that COPD prevalence ranges from 7% to 33.6% among ischemic heart disease patients. Impairment of spirometry positively correlated with the severity of CAD. Our study found a considerable frequency of missed COPD diagnoses. Hence, we recommend that when CAD is diagnosed, the initial evaluation should include a complete history of respiratory symptoms, clinical examination, and spirometry to assess pulmonary function, particularly in those who have risk factors such as smoking and the use of biomass fuel so as to identify COPD at an early stage and treat it. Identifying PRISM can help prevent its progression to COPD by making the required lifestyle modifications. A multidisciplinary approach is advised for all those diagnosed to have CAD.

Introduction

COPD will continue to become more common worldwide (Murray et al., 1997; Sarkar et al., 2021; Tamondong-Lachica et al., 2023; Dange et al., 2023). COPD was the 4th most common cause of death globally, and it was anticipated to rise to the 3rd position by 2020 or sooner(Murray et al., 1997; Lopez et al., 2006). COPD is frequently missed in India due to a lack of spirometry testing and symptoms that appear gradually. The prevalence of COPD varies depending on the study technique and country, but among persons 40 years and older, it ranges from 4% to 20% (Halbert et al., 2006; Buist et al., 2007; Adeloye et al., 2022). The prevalence of Chronic Obstructive Pulmonary Disease in India is 7.4% (Onishi et al., 2014).

***Corresponding Author:** paddy_2020@yahoo.com

Cardiovascular disorders, diabetes, COPD and cancer are among India's most frequent chronic illnesses (Madhu et al., 2022, 2023; Sur et al., 2013; Biswas et al., 2023). As people embrace sedentary behaviours and bad diets, the prevalence of CVDs, diabetes, COPD and cancer is projected to rise (Roy et al., 2023; Sarkar et al., 2023; Paritala et al., 2024). Furthermore, improved diagnostic methods and increased awareness of these disorders lead to higher identification rates (Yach et al., 2004). More than 80% of these individuals go untreated, increasing their risk of cardiovascular complications (Buist et al., 2007; Halbert et al., 2003). Cigarette smoking is a major risk factor for COPD however, not every smoker develops it. Cigarette smoke has also been linked to the development of cardiovascular disease (CVD), which is another leading cause of death worldwide (Yach et al., 2004).

It has been argued that the risk of CVD increases in smokers who develop COPD and COPD could be a risk factor for developing CVD (Sin et al., 2005; Sin et al., 2008). However, the precise prevalence of COPD in CVD patients remains unknown, and there has been little research on COPD screening in CAD patients (Rodriguez-Roisin et al., 2008).

A study conducted in Spain found airflow limitation in 19% of CVD patients (Soriano et al., 2010), whereas airflow limitation was observed in 10%-25% of patients visiting a university hospital's cardiovascular department in Japan (Wada et al., 2010; Yamasaki et al., 2010). However, the risk of comorbid COPD and CVD is poorly understood in India.

COPD and CAD frequently co-exist, adding to the risk of morbidity and mortality. The presence and progression of CAD is one of the causes of COPD exacerbations, which can result in major cardiovascular events, including cardiovascular death.

The coexistence of chronic obstructive pulmonary disease and coronary artery disease is complex and not fully understood. Both these disorders have similar risk factors, namely- smoking, age, diet, sedentary lifestyle and air pollution as well as similar disease pathways like inflammation, hypoxia and oxidative stress (Madhu et al., 2023; Prasad et al., 2023). These factors contribute to the development and progression of both conditions.

Smoking induces inflammatory responses in susceptible individuals, which promote systemic inflammation (Maiti and Samanta, 2018; Dey and Guha, 2020). This inflammation is associated with COPD and the formation, worsening and rupture of the atherosclerotic plaques. These processes can cause coronary artery disease, heart failure, and mortality. Additionally, the hypoxia experienced by COPD patients also contributes to the development of CAD. As a result, screening for COPD in CAD can lead to early intervention and optimal COPD care, resulting in fewer complications and deaths. Therefore, a cross-sectional study was undertaken using spirometry to identify COPD in Coronary Artery Disease patients. This study intends to determine the prevalence of COPD among CAD patients and the relationship between COPD and the patients' underlying cardiac condition.

Materials and Methods

This study was a prospective observational cross-sectional study at Chettinad Hospital and Research Institute in India. All Coronary artery disease (CAD) patients diagnosed by Coronary angiogram attending Cardiology OPD were enrolled into the study after fulfilling inclusion criteria and obtaining written consent. Their demographic details and clinical details were collected through a structured proforma. After obtaining cardiac fitness, all participants were subjected to detailed clinical examination, imaging by Chest X-ray, ECG, 2D-Echo, and spirometry with bronchodilator reversibility.

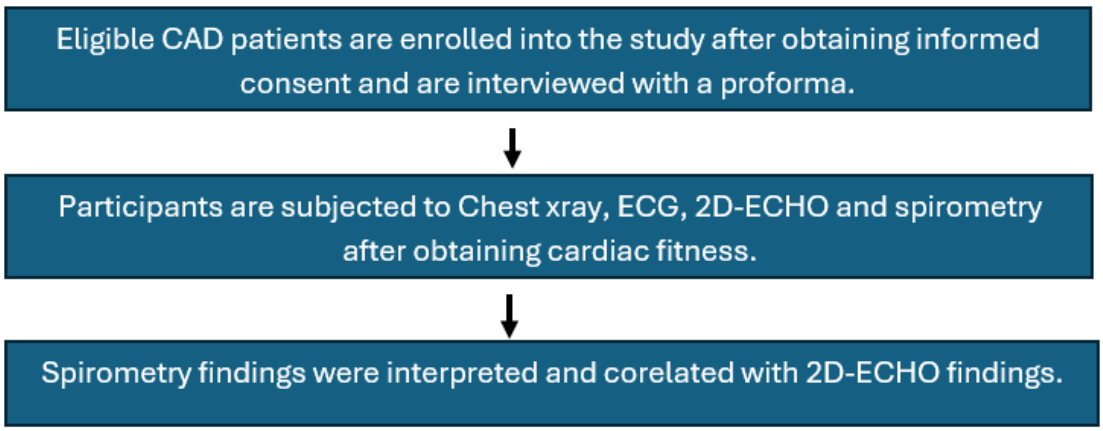

Figure 1. Outline of the research methodology

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Study diagnosis was based on guidelines developed by the Global Initiative for Chronic Obstructive Lung Disease (GOLD, 2023).

Sample Size And Sampling Technique

A convenience sampling technique was used for the study. 293 patients who visited the Cardiology OPD at CHRI, Kelambakkam and met the inclusion criteria were enrolled on the study.

Inclusion Criteria

1) Patients with stable coronary artery disease diagnosed by coronary angiogram.

2) Age: 35-80 years.

3) Gender: All genders.

Exclusion Criteria

1) Patients who do not consent to the study.

2) Patients with contraindications for spirometry as per ATS/ERS guidelines

3)Patients who are previously diagnosed to have COPD.

Table 1. Sex distribution.

Gender	Frequency	Percentage
Male	178	60.7%
Female	115	39.24%

Ethical permission

Ethical committee approval was obtained at our institute to carry on this study (IHEC- I/1103/22)

Statistical analysis

SPSS software, version 25.0, was used to perform statistical analyses.

Result

Profile Of Patients

We enrolled 293 patients diagnosed with coronary artery disease (CAD) through coronary angiography at our center who met the inclusion criteria. The mean age observed among patients was 55.65 years (±8.37). Maximum patients were in the age group 47–57 years (46.07%) (Figure 2). 178 patients (60.7 %) were males and 115 (39.3%) were females (Table 1). 138 patients (47.09 %) in the study group had normal BMI, 0.6 % were underweight, 39.24% were overweight and 12.96%were obese.

21.84 % were smokers, 39.93% were former smokers and 15.6% had exposure to biomass fuel. All the smokers were males.

Symptoms

Amongst the subjects, dyspnoea was the most common symptom (48.1%), followed by cough (13%), breathlessness and cough (3%) and 44.3% of the subjects were asymptomatic (Figure 3).

Chest Xray P/A View:

(81.5%) Chest X-ray was normal, whereas hyperinflation was seen in 11%, cardiomegaly-3.75% and increased broncho vascular markings-3.75% (Figure 4).

Cardiac Status Based On Coronary Angiogram And 2D-ECHO

56.99% of patients had minimal CAD, 10.58% had moderate CAD and 32.4% had severe CAD (figure 5). On echocardiography, 80.54% of patients had a normal left ventricular ejection fraction (LVEF > 55%), 12.28% had LVEF between 50 and 55% and 7.1% had LVEF between 41 and 49%, none had LVEF below 40% (Figure 6). Pulmonary Hypertension was present in 7.84% of the cases, whereas 92.15% had no pulmonary hypertension.

COPD Among CAD Patients

COPD was diagnosed on spirometry when postbronchodilator FEV1/FVC <0.7.

PRISM was diagnosed when postbronchodilator FEV1/FVC>0.7, but other spirometry parameters were abnormal.

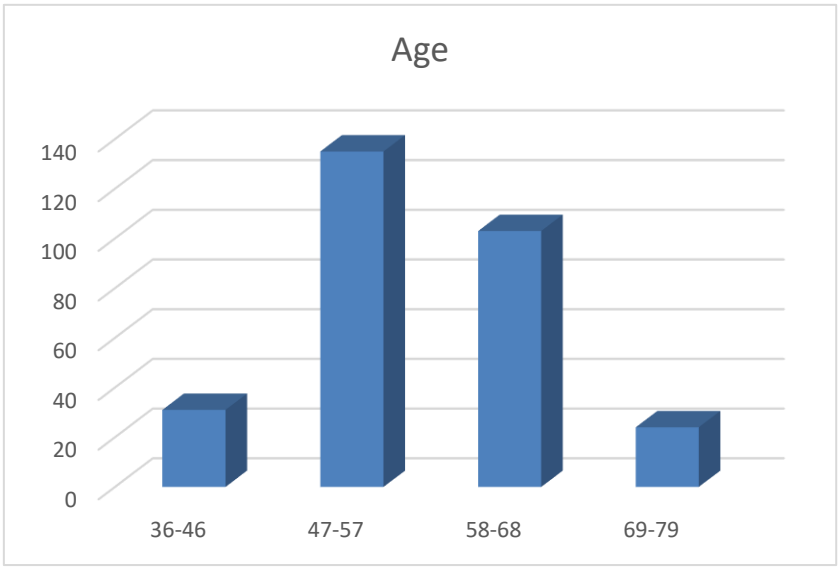

Figure 2. Age distribution.

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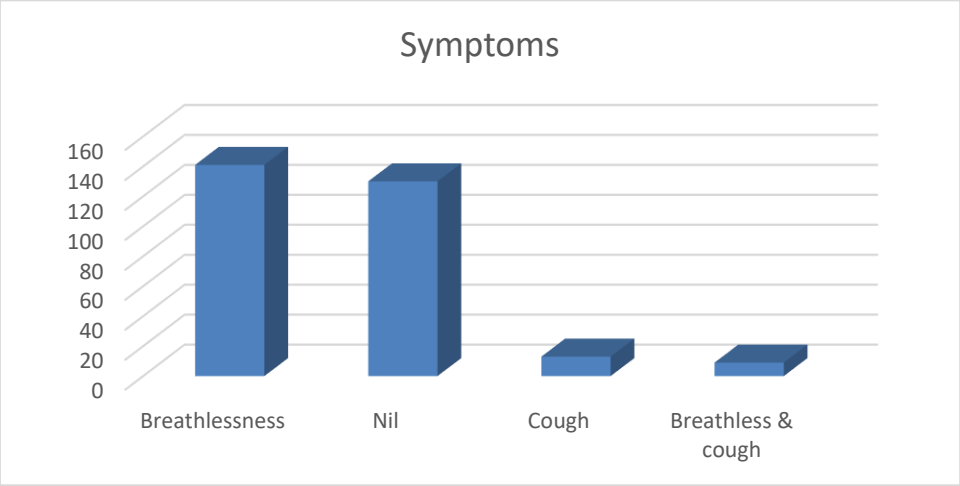

Figure 3. Symptomology.

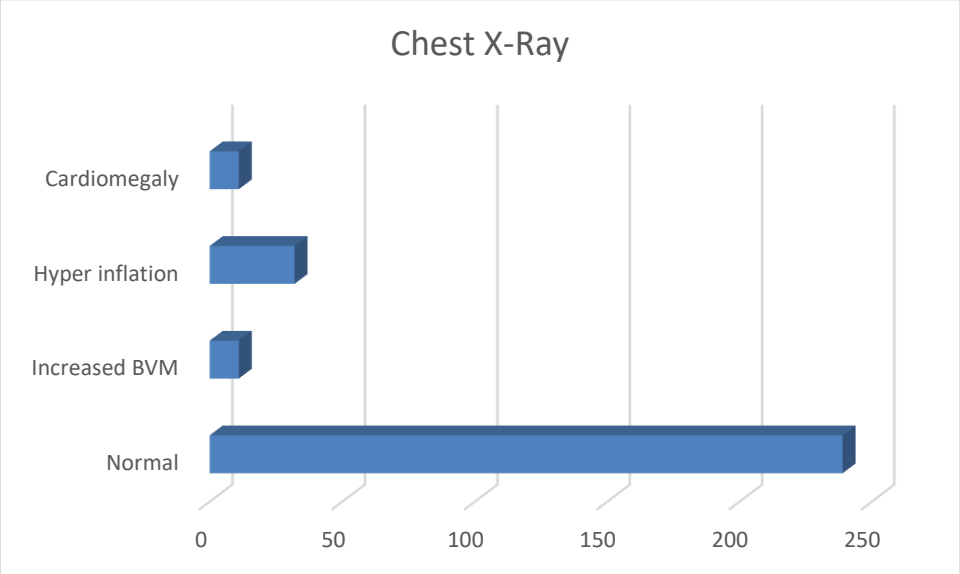

Figure 4. Chest x-ray findings.

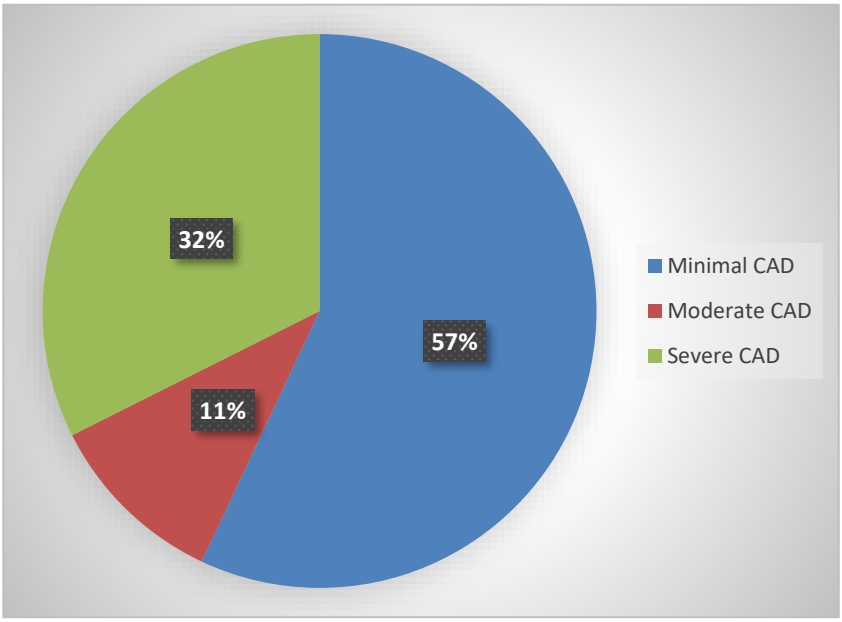

Figure 5. Severity of CAD as per coronary angiogram.

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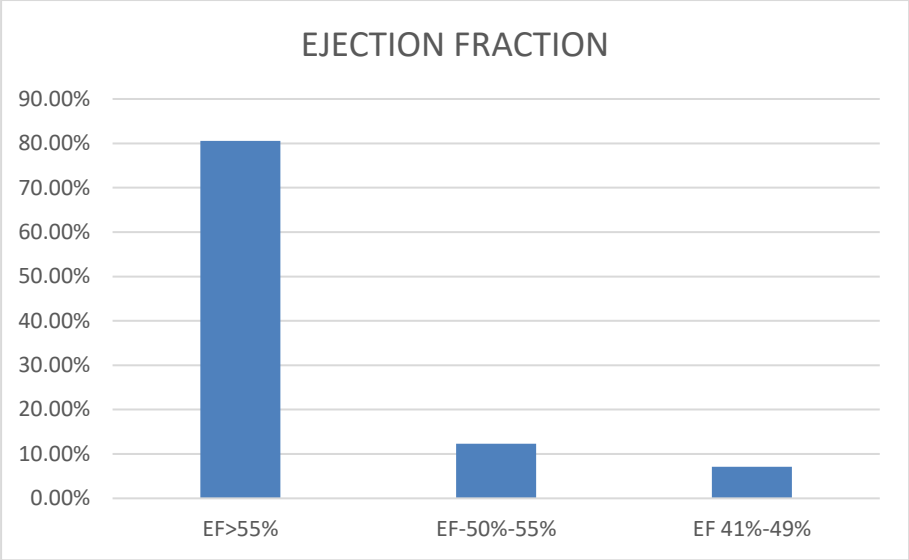

Figure 6. Ejection fraction.

After spirometry, out of 293 patients in the study group, 55 patients (18.77%) were diagnosed to have COPD and 9 patients (3.07%) were diagnosed as PRISM (Preserved ratio impaired spirometry)(Figure 6). In a survey of 5487 female adults over 45 years old, the authors found a 7.1% prevalence of PRISm, similar to our findings (Wijnant et al., 2020). Recent epidemiological research has revealed the prevalence of PRISm is 5.1% in the general population and 12.3 percent among smokers (Wan et al., 2021; Nonato et al., 2015). 229 patients (78.1%) had a normal spirometry. Amongst COPD 32(58.2%) were male and 23(41.8%) were females. Amongst the PRISM candidates- 4(44.4%) were males and 5(55.5%) were females. Among the COPD cases, 10.90% had mild COPD, 89.09% had moderate COPD, and none had severe or severe COPD (Figure 7). Amongst the COPD cases, 30 patients were smokers and 25 patients had biomass fuel exposure.

Association Between Severity Of CAD And Spirometry

We assessed the correlation between the interpretation of spirometry and CAD Severity. According to the chi-square value of 32.47, the P-value was found to be 0.0001. This was statistically correlated and determined to be highly significant. Impairment of spirometry positively correlated with the severity of CAD.

Discussion

The patients had an average age of 55.65 years (±8.37), similar to findings reported in prior research conducted in India and internationally (Rosenberg et al., 2015). Most patients (46.07%) were aged 47 to 57 years. The majority (60.7%) of patients were male, which is a similar finding reported by two prior Indian studies(Mahendra et al., 2018; Agarwal et al., 2019; Balbirsingh et al., 2023; Wijnant et al., 2020; Ferreira et al., 2023). It is fair, given that CAD and tobacco smoking are more common among men. Dyspnea was reported by 48% of patients. Cough symptoms were reported in roughly 4% of the cases. In 3% of cases, cough and dyspnea occurred simultaneously. 44% of the cases were asymptomatic. According to (Alisherovna et al., 2023; Mota et al., 2018; Mannino et al., 2005), cough and dyspnea were present in all cases. This is similar to our study.

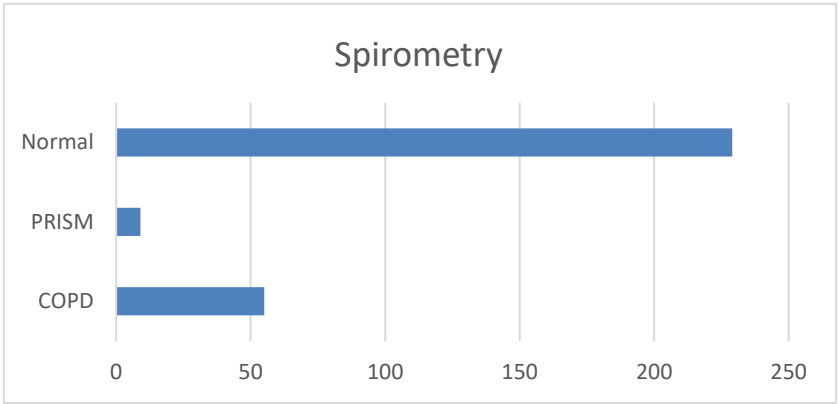

Figure 7. Spirometry interpretation.

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In our study, 82% of the patients demonstrated normal chest X-rays. Atypical x-ray features, such as increased broncho vascular markings, occur in around 3.75% of cases. Cardiomegaly was found in 3.75%. 10.93% had overinflated lung fields. Daher et al. (2020) did a recent study that highlighted the findings of chest X-ray observations. According to the study, around 78% of all cases had normal chest X-ray results. However, it was shown that 5% of cases had cardiomegaly (enlarged heart) and 17% had pleural effusion (Daher et al., 2020).

Tobacco usage is linked to both cardiovascular and obstructive airway diseases. In our study, approximately 21.84% of patients were smokers, while 39.93% were former smokers. This is smaller than that reported by Indian-71% (Mahendra et al.,2018) and international studies-72.6% (Khassawneh et al., 2018).

echocardiographic findings of tricuspid regurgitation, right ventricular enlargement, right atrial enlargement, and pulmonary arterial hypertension. However, none of our research participants experienced tricuspid regurgitation, right ventricular enlargement, or right atrial enlargement. As COPD worsens, these disorders become more widespread, and the risk of cardiac dysfunction rises.

Out of 293 patients with stable CAD, 55 (18.77%) had COPD on spirometry and 9 (3.07%) had PRISM. Outside of India, studies have found that COPD prevalence ranges from 7% to 33.6% among ischemic heart disease patients(Behar et al., 1992; Wada et al., 2010).) In another study with a large number of patients (995), the prevalence of airflow limitation (AL) was reported to be 27%, although pulmonary function testing (PFT) was

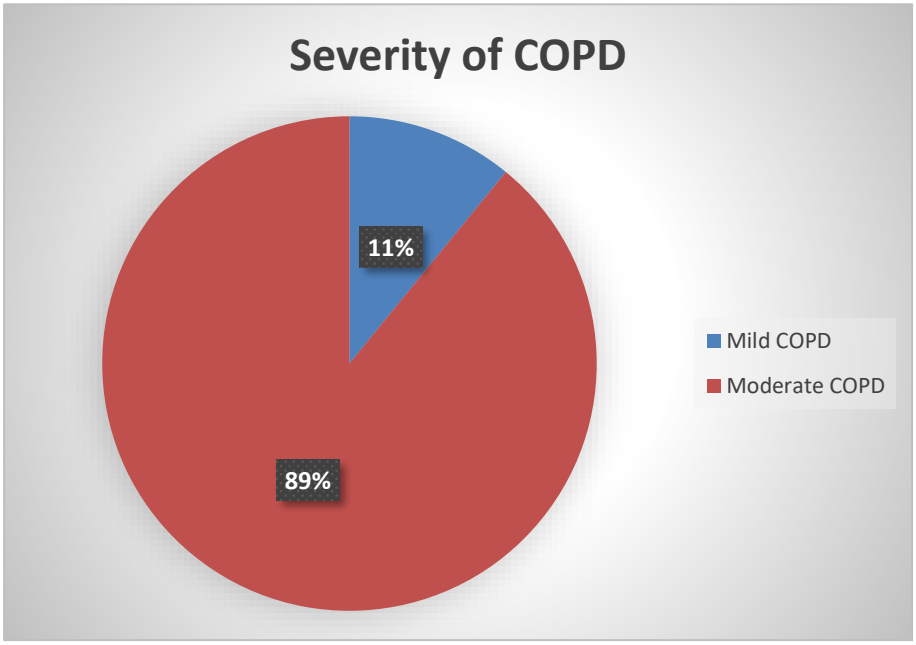

Figure 8. Severity of COPD.

The coronary angiography revealed that the majority of the patients had mild to severe coronary disease. On angiography, the majority of patients (56.99%) had mild CAD, whereas 10.58% had moderate CAD and 32.4% had severe CAD. Out of 293 instances, 80.54% had a normal ejection fraction, while 12.29% showed diastolic dysfunction. 7.17% experienced both systolic and diastolic dysfunction. Nobody had isolated systolic dysfunction. A large percentage of people exhibited diastolic dysfunction, while a lesser number had mixed dysfunction. In the current investigation, about 7.84% of cases had pulmonary hypertension.

Similar to our study (Ansari et al., 2024), the study sought to determine how varying levels of COPD severity influenced echocardiographic results. They concluded that there is a high link between COPD severity and

done using a handheld spirometer and a FEV1/FEV6 < 0.73 was defined as AL (Onishi et al., 2014; Verma et al., 2021). In our study, FEV1/FVC <0.7 post-bronchodilator was considered as airflow limitation. Previous research has found comparable results for underdiagnosis and undertreatment of COPD in patients with ischemic heart disease. (Mahendra et al., 2018; Khassawneh et al., 2018). Ours is one of the few studies to report the incidence of PRISM amongst CAD cases.

Our study had certain limitations like:

Patients with severe COPD and cardiac complications who could not perform Spirometry could not be included in the study.

The actual prevalence of COPD in CAD patients could have been more accurate had we included the known cases of COPD.

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The study had a small sample size and was conducted at a single location, so the findings cannot be generalised to the entire community.

These limitations can be overcome in future studies by enrolling even the known cases of COPD who have been diagnosed as having CAD to know the real prevalence of COPD amongst CAD patients. A larger sample size may be considered for future investigations.

Conclusion

COPD treatment enhances the quality of life and reduces future cardiovascular risk and mortality. Early detection of the presence of obstructive airway illness as soon as the patient's cardiac condition stabilises and timely treatment will result in significant reductions in morbidity and mortality over time. Screening and early detection of COPD in CAD can lead to earlier intervention and optimal COPD care, resulting in fewer complications and deaths. Effective management of COPD and CAD requires a multidisciplinary approach. Collaboration among respiratory and cardiovascular specialists is critical for providing complete care. This missed diagnosis of COPD and PRISM is quite common. Identifying PRISM is especially crucial because these patients can develop COPD in the future.

Lifestyle changes made at the time of PRISM identification may help prevent the development of COPD. We recommend that at the time of CAD diagnosis, the initial evaluation includes a complete history, clinical examination, and spirometry to assess lung function, particularly in patients with risk factors such as smoking and biomass fuel use. Patients diagnosed with COPD should be counselled for smoking cessation and the start of appropriate treatment, as reduction of airway limitation improves cardiovascular health.

Therefore, we conclude that once a patient is diagnosed with CAD by a cardiologist, once stabilised, the patient may be referred to the respiratory medicine physician to analyse the pulmonary function status further so as to identify the undiagnosed COPD and PRISM. A multidisciplinary approach is advised.

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Conflict of Interest

The authors declare no conflict of interest.

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