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Preserved Ratio Impaired Spirometry (PRISm) in Mardan: A Retrospective Prevalence Study of Spirometric Patterns and Associated Comorbidities

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ABSTRACT

Background: Preserved Ratio Impaired Spirometry (PRISm) is a unique form of spirometric abnormality that is defined as reduced FEV_1 (<80% predicted) with a preserved FEV_1/FVC ratio of ≥0.70. Unlike obstructive and restrictive lung disorders, PRISm is increasingly being recognized as a clinically relevant condition that is linked with respiratory symptoms, metabolic syndrome, cardiovascular disease, and increased mortality.

Objective: To determine the prevalence of PRISm among adults undergoing spirometry and to find out its relationship with demographic and comorbid factors.
Methodology: A retrospective study design was used to examine 180 spirometric results from adult patients (≥18 years old) in a tertiary care hospital in Peshawar from January 2023 to December 2024. The variables collected for analysis were age, gender, BMI, smoking status, comorbidities, and spirometric values. PRISm was defined as FEV1 <80% predicted with FEV1/FVC ≥0.70.

Results: Out of 180 patients, the mean age was 46.7 ± 13.2 years, and 52.2% of them were males. PRISm prevalence was 15.5% (n=28), normal spirometry 51.6% (n=93), and obstructive pattern 32.7% (n=59). PRISm patients had significantly decreased FVC (72.5 ± 6.7%) compared with normal and obstructive patients (p<0.001). PRISm was significantly associated with hypertension (39.2% vs. 21.7%, p=0.024), diabetes mellitus (35.7% vs. 17.7%, p=0.037), and cardiovascular disease (25% vs. 9.8%, p=0.024), diabetes mellitus, and cardiovascular disease (25% vs. 9.8%, p=0.048).

Conclusion: PRISm is a common intermediate spirometric phenotype within this population and has been linked with many cardiometabolic comorbidities and obesity. It may be beneficial to recognize this within clinical practice in order to potentially prevent the progression of this into pulmonary and systemic disorders.

Keywords: Preserved Ratio Impaired Spirometry; Spirometry; Pulmonary Function Test; Obstructive Lung Disease

Introduction

Preserved Ratio Impaired Spirometry (PRISm) is an increasingly identified spirometric defect defined by the presence of an impaired forced expiratory volume in one second (FEV_1 <80% predicted) along with an associated normal FEV_1/FVC ratio (≥0.70).[1,2] Unlike the traditional presentation of Obstructive Lung Diseases like Chronic Obstructive Pulmonary Disease (COPD), in which the hallmark is the reduced FEV_1/FVC ratio, the new entity of PRISm is an unusual physiological state not categorized under Obstructive or Restrictive Lung Diseases. This new entity has come into the medical literature in the last few years with the recognition of its association with increased Respiratory Symptoms, Metabolic Syndrome, Cardiovascular Disease, and Mortality.[3]

Spirometry continues to be a mainstay in the diagnosis of respiratory diseases in the field of respiratory medicine, particularly in the assessment of chronic symptoms of lung disease and the classification of abnormal lung function. Conventional spirometry results can be classified into normal, obstructive, or restrictive lung function abnormalities. However, the conventional approach to understanding spirometry results has been challenged in the presence of PRISm. Patients with PRISm may present with abnormal lung function without any evidence of obstruction, thereby complicating diagnosis and clinical decision-making in the management of the disease. New evidence suggests that PRISm may be a precursor to COPD in certain patients, while in other patients, it may lead to restrictive lung disease or may persist as a static state.[4,5]

The prevalence of PRISm varies worldwide, ranging from 7% to 20%.[16] This variation can be attributed to demographic, smoking, obesity, environmental factors, and spirometric reference values differences. Several studies that followed the same individuals over time found that individuals with PRISm had an increased risk for developing COPD, especially if they were smokers and had respiratory symptoms.[6-8] PRISm has also been linked with systemic inflammation, metabolic syndrome, diabetes mellitus, and cardiovascular diseases, suggesting that PRISm might be part of a systemic syndrome rather than a localized pulmonary phenomenon.

In low- and middle-income countries, including Pakistan, the impact of respiratory diseases is considerable, mainly due to high rates of smoking, exposure to biomass fuels, urban air pollution, respiratory infections, and occupational exposures. In spite of the increased awareness regarding PRISm worldwide, there is a lack of information regarding the prevalence, presentation, and risk factors for PRISm in the local population. In Pakistan, the majority of the epidemiological studies conducted on respiratory diseases were based on well-defined respiratory diseases, such as COPD, asthma, and tuberculosis, while there has been a lack of information regarding intermediate spirometric patterns, i.e., PRISm.

The recognition of PRISm is clinically relevant for several reasons. First, patients with PRISm often have respiratory symptoms such as dyspnea, chronic cough, and exercise intolerance, but they may not have COPD. Second, failure to recognize PRISm may lead to inappropriate monitoring and risk stratification. Third, recognition of PRISm offers an opportunity to implement interventions, such as smoking cessation, weight reduction, and optimization of comorbidities, which could influence the course of the disease. The use of a retrospective prevalence study would help to ascertain the burden of PRISm by analyzing the existing records of pulmonary function tests performed within the population, which would assist in creating awareness regarding the condition and its possible associations with certain risk factors.

Objective

To determine the prevalence of PRISm in patients undergoing spirometry and contribute to the growing body of knowledge for a newly recognized respiratory disease.

Methodology

This retrospective prevalence study was carried out in the Department of Pulmonology, Mardan Medical Complex, Mardan, Pakistan. The research methodology included the analysis of previous spirometry reports and related data of adult patients who underwent pulmonary function tests during the data collection period, which was from January 2023 to December 2024.

The total of 180 spirometry reports were included in this study. The sample size was considered adequate for the purpose of estimating the prevalence of Preserved Ratio Impaired Spirometry (PRISm). A non-probability consecutive sampling method was adopted. The sampling frame included data of all adult patients who are 18 years and above, who have undergone spirometry and have acceptable and reproducible results.

The exclusion criteria included those patients who were diagnosed with conditions such as chronic obstructive pulmonary disease (COPD), bronchial asthma, interstitial lung disease, and pulmonary tuberculosis. The data were also excluded if they are not complete and if the spirometry results were not acceptable and reproducible.

Preserved Ratio Impaired Spirometry (PRISm) was operationally defined as a reduction in FEV1 to less than 80% predicted, with a preserved FEV1/FVC ratio of 0.70 or more. The patients were classified into normal spirometry, obstructive pattern with FEV_1/FVC ratio of less than 0.70, and PRISm pattern with FEV_1 <80% predicted with FEV_1/FVC ≥0.70, based on spirometric

findings.

The data was collected from the hospital files with the help of a structured data collection proforma. The data collected included demographic information, smoking habits, body mass index, reasons for performing spirometry, and spirometric values, which included FEV1, FVC, FEV1/FVC ratio, and percentage predicted values. The main outcome variable included the presence or absence of PRISm, while independent variables included age, gender, smoking habits, BMI, and comorbidities.

Data was analyzed using SPSS version 26.0. Quantitative data like age and BMI are expressed as mean and standard deviation, while qualitative data like gender, smoking status, and spirometric patterns are expressed as frequencies and percentages. The Chi-square test was used to determine the association of PRISm with categorical data, while the independent sample test was used for continuous data. A p-value of less than 0.05 was considered as statistically significant. Ethical approval was collected form the Institutional Review Board of the Mardan Medical Complex before the data collection process. The confidentiality of the data was ensured by anonymizing the data during analysis.

Results

A total of 180 spirometry reports were included in the study. The mean age was 46.7 ± 13.2 years, and the majority (36.1%) of the population were in the 46-60 years age group. Males comprised 52.2% of the population, and females comprised 47.7% of the population. With respect to smoking habits, the majority of the population

Table 1. Baseline Characteristics of the Study Population

Variable	Frequency (n)	Percentage (%)	Mean ± SD
Age (years)			
18–30 years	30	16.6%	46.7± 13.2
31–45 years	56	31.1%	
46–60 years	65	36.1%	
>60 years	29	16.1%	
Gender			
Male	94	52.2%	_
Female	86	47.7%	
Smoking Status			
Current Smokers	43	23.8%	_
Ex-Smokers	25	13.8%	
Non-Smokers	112	62.2%	
Body Mass Index (kg/m²)			
Underweight (<18.5)	21	11.6%	26.5± 4.1
Normal (18.5–24.9)	63	35.0%	
Overweight (25–29.9)	46	25.5%	
Obese (≥30)	50	27.7%	

Table 2. Distribution of Spirometric Patterns and Pulmonary Function Parameters

Parameter	Normal (n=93)	Obstructive (n=59)	PRISm (n=28)	p-value
FEV_1 (% predicted)	92.1± 8.3	62.3 ± 8.9	92.3 ± 8.4	<0.001
FVC (% predicted)	94.3 ± 7.4	77.7 ± 8.4	72.5 ± 6.7	<0.001
FEV_1/FVC ratio	0.83 ± 0.05	0.59 ± 0.05	0.76 ± 0.03	<0.001
Prevalence (%)	51.6%	32.7%	15.5%	-

(62.2%) were non-smokers. Furthermore, 23.8% of the population were current smokers and 13.8% were Ex-smokers. The mean Body Mass Index (BMI) was 26.5 ± 4.1 kg/m² (Table 1).

According to the BMI categories, the subjects were classified as underweight, normal weight, overweight, and obese. In this study, 11.6% were underweight, 35.0% were normal weight, 25.5% were overweight, and 27.7% were obese. Overall, more than half of the participants were classified as overweight and obese, which shows a high prevalence of increased BMI (Figure 1).

Normal spirometry was observed in 51.6% (n=93) of cases, an obstructive pattern was observed in 32.7% (n=59) of cases, and PRISm was observed in 15.5% (n=28) of cases. The mean FEV_1 was significantly reduced in the obstructive pattern group compared to the normal and PRISm groups (62.3 ± 8.9% vs. normal and PRISm groups, $p<0.001$). FVC was lowest in the PRISm group, while the FEV_1/FVC ratio was markedly reduced in the obstructive pattern group (0.59 ± 0.05). The differences in all parameters were statistically significant ($p<0.001$) (Table 2).

Hypertension was also noted among the PRISm patients, which was 39.2% compared to the non-PRISm group, where the value was 21.7%. However, the difference was noted to be statistically significant at $p = 0.024$. In addition, diabetes mellitus was noted to be associated with PRISm, where the value was 35.7% compared to the non-PRISm group, where the value was 17.7%. The difference was noted to be statistically significant at $p = 0.037$. In addition, cardiovascular disease was noted to be associated (Table 3).

Discussion

This is a retrospective study that sought to determine the prevalence and clinical associations of Preserved Ratio Impaired Spirometry (PRISm) among patients undergoing spirometry. The overall prevalence of PRISm among our patient population was 15.5%, which is consistent with the 7-20% global range. This demonstrates that PRISm is not an uncommon phenomenon during spirometry; rather, it is a physiological state with significant clinical implications for the patient. Preserved Ratio Impaired Spirometry (PRISm) is a unique pattern of spirometry that is characterized by a decrease in forced expiratory volume in 1 second (FEV_1) with the preservation of the FEV_1 to forced vital capacity (FVC) ratio. PRISm does not meet the traditional criteria for obstructive or restrictive lung disease, but its presence has been linked to an increased risk of respiratory symptoms, co-morbidities, and mortality. The prevalence of PRISm has been observed to vary worldwide, depending on demographic, environmental, and lifestyle factors, and may be associated with small airways disease and decreased lung volumes. Longitudinal studies have demonstrated that PRISm is a dynamic phenotype, with many individuals demonstrating normal spirometry or chronic obstructive pulmonary disease (COPD) over time, especially those with borderline FEV_1/FVC ratios, older age, and active smoking status. The importance of PRISm lies in the identification of high-risk individuals and the development of targeted interventions to monitor and manage long-term respiratory outcomes.

Our study prevalence rate is similar to other larger population-based studies. In a US national spirometry data-based study (2007-2012), it was found that approximately 10% of adults suffered from PRISm and 14% suffered from COPD. This study was done by Cadham et al., (2024). This was associated with an increased risk of mortality, which indicates the importance of PRISm. However, the progression of PRISm to COPD still remains unclear and underlines the necessity of acquiring spirometric data in larger populations.[9] In a study done by Wijnant et al., (2020), it was found that approximately 7.1% of adults suffered from PRISm.[10] This showed heterogeneous trajectories, with 15.7% reversing to normal spirometry and 49.4% progressing to COPD. PRISm was associated with an accelerated rate of decline in lung function, particularly in incident cases. In addition, PRISm was associated with significantly higher mortality, particularly for cardiovascular and all-cause mortality.[10] The slightly higher prevalence of PRISm in our study may have been due to various reasons, including the population sampled in the two studies, environmental factors, and the

Table 3. Association of PRISm with Comorbid Variables

Variable	PRISm (n=28)	Non-PRISm (n=152)	p-value
Hypertension	11 (39.2%)	33 (21.7%)	0.024*
Diabetes Mellitus	10 (35.7%)	27 (17.7%)	0.037*
Cardiovascular Disease	7 (25%)	15 (9.8%)	0.048*

prevalence of metabolic disorders in South Asians.

In our research, PRISm patients showed a significantly decreased FVC, whereas the FEV1/FVC ratio was maintained. This supports the hypothesis that PRISm could represent early restrictive lung disease, air trapping, obesity, and small airway disease rather than airflow limitation. According to a study done by Fortis et al., (2020), it was stated that one quarter of patients with PRISm could progress towards developing COPD. Patients with decreased FVC/TLCCT ratio are at a higher risk of developing emphysema and gas trapping, leading to airflow limitation. Patients with decreased FVC/TLCCT ratio show more severe and more frequent exacerbations of symptoms.[11] A study by Zhao et al., (2022) found that preserved ratio impaired spirometry (PRISm) is strongly linked with small airway dysfunction and decreased total lung capacity among the Chinese population.[12] The individuals with PRISm had a higher likelihood of abnormal spirometry, impulse oscillometry, and CT scan findings, which shows the association with peripheral airway dysfunction.

A vital point to note in this study was the link between PRISm and cardiometabolic comorbidities. Hypertension, diabetes mellitus, and cardiovascular diseases were all more common in patients with PRISm compared to those without PRISm. These findings are in line with previous international studies. In a study done by Tang et al., (2024) on PRISm and diabetes, it was established that patients with diabetes were more likely to develop PRISm compared to those without diabetes. Higher blood glucose levels and the duration of diabetes increased the risk of developing PRISm. In addition, the more health complications patients with diabetes experienced, the higher their chances of developing PRISm. Therefore, good blood sugar control and lung function tests are vital in diabetic patients.[13] Another study done by Huang et al.,

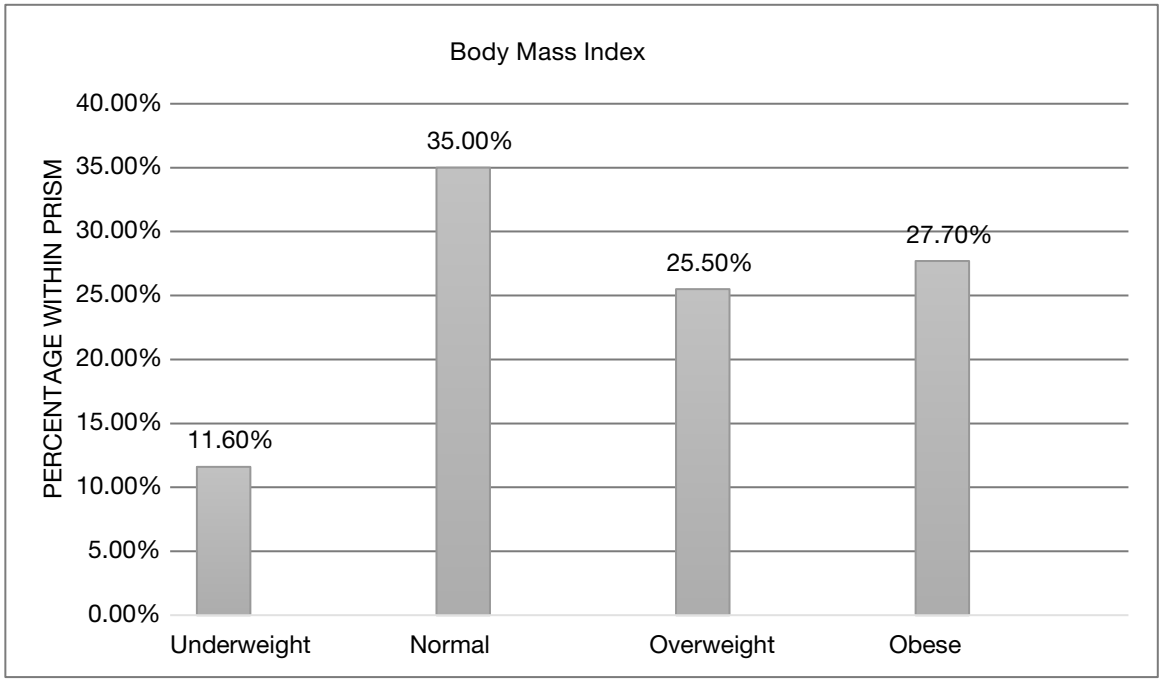

Figure 1. Preserved ratio impaired spirometry distribution according to body mass index

(2024) on PRISm and its link with comorbidities revealed that PRISm is strongly linked with hypertension and type 2 diabetes, making its management more difficult.[14] In addition, the Genome-wide association study of preserved ratio impaired spirometry (PRISm) by Higbee et al., (2024) indicated that there was a strong genetic correlation between PRISm and COPD, as well as a significant association with type 2 diabetes.[15] These genes were also linked with diabetic traits and blood pressure. These observations indicate that there is a shared link between PRISm and lung and cardiovascular diseases, as well as diabetes and hypertension. Moreover, the COPDGene Study indicated that PRISm was linked with increased all-cause mortality, especially cardiovascular-related mortality.

The high incidence of overweight and obese people in the present study (>50%) might also play a role in the development of PRISm. Obesity has been consistently recognized as a risk factor for the development of PRISm. This might be because obese people have reduced chest wall compliance, reduced functional residual capacity, and abnormal respiratory mechanics. PRISm has been termed an 'obesity-related spirometric phenotype' in several studies. According to a study by Wan (2022), PRISm is often seen in people with high body mass index, thus obese. It has been seen that high as well as low BMI can predispose people to PRISm.[16] With the rise in obesity in Pakistan, PRISm might emerge as an emerging public health issue.

Smoking is still an essential risk factor in the development of abnormal spirometric patterns. Although the majority of participants in our study are non-smokers, there are still a significant number of current and former smokers. Longitudinal studies from COPDGene have shown that some patients with PRISm progress to COPD. Tran et al. (2023) found in their study that individuals with a smoking history of ≥ 10 pack-years are at higher risk of having undiagnosed airflow obstruction (AFO) or developing COPD during 5-year longitudinal follow-up.[17] Current smoking and smoking exposure are strongly associated with abnormal spirometry. Thus, smoking plays an essential role in COPD. It is suggested that PRISm might be an "intermediate or 'transitional' state in the natural history of chronic airflow limitation in susceptible individuals."

The clinical importance of the identification of PRISm cannot be overemphasized. For instance, individuals with PRISm present with respiratory symptoms despite not meeting the criteria for COPD. Secondly, individuals with PRISm seem to have a higher burden of systemic comorbid conditions and possibly mortality. Thirdly, it seems that PRISm is not a fixed clinical entity and can potentially develop into COPD, restrictive lung disease, or return to normal spirometry.

The results emphasize the fact that PRISm is a common spirometric abnormality, and its significant association with cardiometabolic comorbidities underlines the importance of a multidisciplinary approach in the evaluation and management of the condition. It is suggested that further studies, including prospective studies with a large population, should be undertaken to determine the prognosis of PRISm in the Pakistani population.

Conclusion

In conclusion, PRISm is an important intermediate spirometric phenotype in our setting, comparable to international data, and is strongly linked with metabolic and cardiovascular risk factors. The recognition of this entity in spirometric reporting may aid in the early stratification and intervention of risk factors.

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