

การศึกษาย้อนหลังแบบโคฮอร์ตของความชุกและปัจจัยเสี่ยงของภาวะ Preserved Ratio Impaired Spirometry (PRISm) ในประชากรผู้ป่วยโรงพยาบาลพัทยาศึกษา

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รับลงตีพิมพ์ 6 มิถุนายน 2569

บทคัดย่อ

ที่มาของปัญหาและวัตถุประสงค์

ภาวะ preserved ratio impaired spirometry (PRISm) เป็นรูปแบบผลตรวจสมรรถภาพปอดที่ค่า FEV₁ ลดลง แต่ FEV₁/FVC และ FVC ยังอยู่ในเกณฑ์ปกติ ซึ่งมักถูกตีความว่าปกติทั้งที่มีความผิดปกติทางสรีรวิทยา มีรายงานว่าภาวะนี้สัมพันธ์กับการเพิ่มขึ้นของโรคทางเดินหายใจ และการเสียชีวิต อย่างไรก็ตาม ความชุกและความสำคัญทางคลินิกของยังไม่ชัดเจน การศึกษานี้มีวัตถุประสงค์เพื่อหาความชุก ปัจจัยเสี่ยง และผลลัพธ์ทางคลินิกของภาวะ PRISm ในโรงพยาบาลพัทยาศึกษา

วิธีการศึกษา

เป็นการศึกษาย้อนหลังในผู้ป่วย 710 รายระหว่างเดือนมกราคม พ.ศ. 2558 ถึงเมษายน พ.ศ. 2569 โดยนิยามของภาวะ PRISm ใช้ทั้งเกณฑ์ LLN และ fixed ratio โดยจะเก็บข้อมูลได้แก่ ข้อมูลพื้นฐาน โรคร่วม การนอนโรงพยาบาล และการเสียชีวิตจากระบบคอมพิวเตอร์ นำมาวิเคราะห์ความชุกด้วยสถิติเชิงพรรณนา ประเมินปัจจัยเสี่ยงและความสัมพันธ์ของผลลัพธ์ทางคลินิก

ผลการศึกษา

ความชุกของ PRISm เท่ากับ 9.0% โดยพบ 3.2% ตามเกณฑ์ LLN และ 8.9% ตามเกณฑ์ fixed ratio ปัจจัยเสี่ยงที่มีนัยสำคัญคือ เพศหญิง การสูบบุหรี่ และภาวะอ้วน โดยไม่พบความแตกต่างของอัตราการเสียชีวิต แต่พบการนอนโรงพยาบาลสูงขึ้นโดยเฉพาะจากโรคทางเดินหายใจ

สรุป

ภาวะ PRISm พบได้ไม่น้อยและสัมพันธ์กับการนอนโรงพยาบาลที่เพิ่มขึ้นจึงไม่ควรถูกมองข้าม การตรวจพบตั้งแต่ระยะแรกและการจัดการปัจจัยเสี่ยง จะช่วยให้ผลลัพธ์ดีขึ้นได้

คำสำคัญ

Preserved ratio impaired spirometry, PRISm, ความชุก, ปัจจัยเสี่ยง, การนอนโรงพยาบาล

A Retrospective Cohort Study on the Prevalence and Risk Factors of Preserved Ratio Impaired Spirometry (PRISm) at Pattaya Bhattamakun Hospital

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Abstract

Background: Preserved ratio impaired spirometry (PRISm) is defined by a reduced FEV_1 with a preserved FEV_1/FVC ratio and FVC. In practice, this pattern is often interpreted as normal, despite underlying abnormalities. Previous studies have suggested that PRISm may be associated with adverse outcomes, but its prevalence and clinical significance are still not clearly established. This study aimed to determine the prevalence of PRISm and explore its associated risk factors and clinical outcomes at Pattaya Bhattamakun Hospital.

Methods

A retrospective cross-sectional study was conducted including 710 patients who underwent pulmonary function testing between January 2015 and April 2026. PRISm was defined using either lower limit of normal (LLN) or fixed-ratio criteria. Data on demographics, comorbidities, hospitalizations, and mortality were collected from ICD-10 records. Logistic regression was used to identify risk factors, and correlations with outcomes were assessed using Spearman's rank test.

Results

The prevalence of PRISm was 9.0% (95% CI: 6.9–11.1). When classified separately, prevalence was 3.2% by LLN and 8.9% by fixed-ratio criteria. Female sex, smoking, and obesity were independently associated with PRISm. There was no significant association with all-cause mortality, but PRISm was associated with increased hospitalizations, particularly those related to airway disease.

Conclusions

PRISm was not uncommon in this population and was associated with a higher risk of hospitalization. These findings suggest that PRISm should not be overlooked in clinical practice. Further studies are needed to better understand its long-term outcomes and management.

Keywords

Preserved ratio impaired spirometry, PRISm, prevalence, risk factor, hospitalization

Introduction

Abnormal pulmonary function tests are usually classified as obstructive, restrictive, or mixed patterns. However, in clinical practice, some results do not clearly fit into these categories and are often still interpreted as normal. These are sometimes referred to as non-specific patterns. According to the ERS/ATS technical standard in 2021, a non-specific pattern is defined by a reduced forced vital capacity (FVC) and/or forced expiratory volume in 1 second (FEV1), with a normal FEV1/FVC ratio and normal total lung capacity (TLC).¹

Preserved ratio impaired spirometry (PRISm) is another pattern that has been described in this context. It refers to a proportional reduction in FEV1 and FVC, while the FEV1/FVC ratio remains normal.^{2,3} However, there is still no single agreed definition. The ERS/ATS 2021 document describes PRISm as a non-specific pattern with FEV1 below the lower limit of normal (LLN), which may represent early or evolving airway disease. On the other hand, the GOLD 2024 report defines PRISm as $FEV1/FVC \geq 0.7$ after bronchodilator use, with $FEV1 < 80\%$ of predicted, particularly in current or former smokers.⁴

The prevalence of PRISm varies across studies, depending on the population and definition used. It is generally reported around 5–10% in population-based studies and can reach up to about 13% among smokers, such as in the COPDGene cohort.^{5–12} A systematic review published in 2025 reported that the prevalence of PRISm was 12.0%.¹³ Several factors have been linked to PRISm, including smoking status, obesity, and both low and high BMI. Female sex has also been reported in some studies.^{9,10} In addition, PRISm is considered an unstable pattern, as lung function may remain stable, improve to normal, or progress to obstructive or restrictive patterns over time.³

Previous studies have also suggested that PRISm may be associated with worse outcomes, including higher risks of all-cause mortality, cardiovascular disease (such as ischemic heart disease and heart failure), and respiratory events like pneumonia or COPD exacerbations.^{5,6,14,15} However, most of these data come from Western populations. There are fewer studies in Asian populations, and even fewer in Southeast Asia. Although some reports from Japan, South Korea, and China exist, differences in population characteristics may limit generalization to Thai patients.

To address this gap, this study aims to determine the prevalence of PRISm in a hospital-based population in Thailand, and to explore its associated risk factors and clinical outcomes.

Methods

Study design and study population

This retrospective cross-sectional study was approved by the Chonburi Provincial Public Health Office (certificate of approval: CBO Rec 2569-008). The sample size was calculated to estimate a single proportion using the “estimating proportion of one group” formula. Based on a previous study reporting a PRISm prevalence of 12%¹³, with a 95% confidence level and 20% relative precision, the required sample size was approximately 705 patients. Therefore, a total of 710 patients were included. The inclusion criteria were patients aged over 18 years who underwent spirometry at the pulmonary function lab of Pattaya Bhattamakun Hospital for any indication between January 2015 and April 2026. Patients with incomplete medical records were excluded. Demographic data, smoking status, comorbidities (including diabetes, hypertension, dyslipidemia, cardiovascular disease, neurological disease, and pulmonary disease),

medical history, hospital admissions, and mortality were collected using ICD-10 codes. Laboratory data included the blood eosinophil count (BEC) closest to the date of spirometry.

Variable definition

PRISm was defined based on the Global Lung Function Initiative (GLI) 2012 reference values as either FEV1 below the lower limit of normal (LLN) with FVC and FEV1/FVC at or above the LLN, or FEV1 < 80% predicted with FVC ≥ 80% predicted and FEV1/FVC ≥ 75% for patients aged ≤ 40 years or ≥ 70% for those aged > 40 years

Statistical analysis

Prevalence was calculated. Continuous variables were described using medians and interquartile ranges (IQR). The categorical variables were presented as frequencies and percentages. Chi-square and Wilcoxon rank sum tests were used to compare categorical and continuous variables between groups. The association between risk factors and outcomes were assessed by logistic regression analysis. Multivariable models were developed by adjusting for covariates with $p < 0.25$ in univariate models. Spearman's rank correlation was used to determine factors associated with mortality rate. The data were analyzed using STATA version 19.0 (StataCorp LLC College Station, Texas 77845 USA).

Results

Prevalence of PRISm and its characteristics A total of 710 patients were included in this study. In the overall cohort, 43.9% were female and 72.5% were non-smokers. Normal spirometry was observed in 285 patients (40.1%), while obstructive, restrictive, and mixed ventilatory impairments were found in 192 (27.0%), 69 (9.7%), and 100 patients (14.1%), respectively. The overall prevalence of PRISm was

9.0% (95% CI: 6.9–11.1) when defined by either LLN or fixed ratio criteria. When analyzed separately, the prevalence was 3.2% (95% CI: 1.9–4.5) using the LLN criteria and 8.9% (95% CI: 6.8–11.0) using the fixed ratio criteria. Compared with patients who had normal spirometry (Table 1), those in the PRISm group tended to be more often female (75.0% vs 49.8%), more likely to be smokers (50.0% vs 42.1%), and had a higher proportion of BMI ≥ 30 (29.7% vs 14.0%). The median age in the PRISm group was slightly lower (59.5 vs 61 years). In terms of comorbidities, chronic kidney disease appeared to be more common in the PRISm group (14.1% vs 7%).

Risk factors

To identify risk factors for PRISm, the analysis was conducted in three steps. First, univariate analysis was performed to examine the association between each factor and PRISm. Following the recommendation of Hosmer and Lemeshow¹⁶, a p-value threshold of 0.25 was used as a screening criterion. Second, variables with p-values < 0.25 and those identified as significant in previous studies were included in the multivariable model. Third, backward elimination was applied to derive the fitted model. The results are presented as odds ratios (ORs) with 95% confidence intervals (CIs), and a two-sided p-value < 0.05 was considered statistically significant. An OR greater than 1 suggests increased odds of the outcome, while an OR less than 1 indicates decreased odds. An OR of 1 indicates no association between the predictor and the outcome. 17, 18

Table 2 shows the results of the univariate logistic regression analysis, which identified 10 variables initially as potential candidates for the multivariable logistic regression model. Those included Sex, Age, Smoking status, Weight, Height, BMI, BMI ≥ 30, and Co-morbidities

including IFG, OSA, and CKD. During the multivariable model fitting process using backward elimination, variables that were not statistically significant at an alpha level of 0.10 were sequentially removed by iteratively eliminating the least significant variable (i.e., the variable with the highest p-value).

The fitted model included Sex, Age, Smoking status, Height, Obesity, and CKD. Smoking status showed a borderline association with PRISm. Although its p-value did not meet the predefined inclusion criterion of < 0.25 in the univariable analysis, Smoking status has been identified as a significant factor in previous studies.⁵⁻¹³ Therefore, it should be retained in the multivariable model to avoid excluding a potentially important factor. Variables including Weight, BMI, IFG, and OSA were removed from the multivariable model during the backward elimination process because their p-values exceeded 0.10. The overall model was statistically significant (likelihood ratio chi-square statistic = 31.08, p-value < 0.001), indicating that the included risk factors were associated with PRISm.

Sex was significantly associated with PRISm, with an OR of 3.88 (95% CI: 1.77 - 8.53; p-value = 0.001), indicating that females had approximately fourfold higher odds of having PRISm compared with males. Smoking status

was also significantly associated with PRISm (OR 2.01; 95% CI: 1.09 - 3.69; p-value = 0.024), with smokers having twice the odds of PRISm compared with non-smokers. In addition, Obesity, measured as a body mass index (BMI) ≥ 30 kg/m², was associated with PRISm (OR 2.42; 95% CI: 1.22 - 4.82; p-value = 0.011), individuals with BMI ≥ 30 kg/m² had 2.42 times higher odds of PRISm compared to those with a BMI below 30. Chronic kidney disease (CKD) showed a significant association with PRISm, with more than twofold higher odds observed (OR 2.60; 95% CI: 1.01 - 6.70; p-value = 0.047). This finding may indicate a potential role of comorbidities in PRISm and warrants further investigation. Age and Height did not show a statistically significant association with PRISm in this model.

Model adequacy was assessed using the Hosmer-Lemeshow test¹⁹, a commonly used global goodness-of-fit (GOF) test²⁰ for evaluating the overall fit of a logistic regression model. A non-significant p-value (Hosmer-Lemeshow Chi-squared = 9.71, p-value = 0.286) indicates good model fit. Moreover, the area under the receiver operating characteristic (ROC) curve (AUC) was used to assess the overall diagnostic accuracy of the model. The AUC was 0.7031, which is considered acceptable.²¹

Table 1. Comparison of baseline characteristics of those with PRISm and normal spirometry

	PRISm (N = 64)	Normal (N = 285)
Female, n (%)	48 (75.0)	142 (49.8)
Age (years)	59.5 (45.8-68)	61 (52-71)
Smoker, n (%)	32 (50.0)	120 (42.1)
Weight (Kg)	65 (56.8-79.8)	63 (55-73)
Body mass index (kg/m ²)	26.1 (21.8-30.2)	24.8 (21.1-27.7)
Body mass index $\geq$ 30, n (%)	19 (29.7)	40 (14.0)
Underlying, n (%)		
Diabetes mellitus	17 (26.6)	75 (26.3)
Hypertension	33 (51.6)	127 (44.6)
Dyslipidemia	25 (39.1)	112 (39.3)
Impaired fasting glucose	3 (4.7)	4 (1.4)
Ischemic heart disease	2 (3.1)	13 (4.6)
Congestive heart failure	1 (1.6)	12 (4.2)
Atrial fibrillation	2 (3.1)	5 (1.8)
Stroke	1 (1.6)	14 (4.9)
Allergic rhinitis	20 (31.3)	82 (28.8)
Obstructive sleep apnea	2 (3.1)	2 (0.7)
Chronic kidney disease	9 (14.1)	20 (7.0)
Cancer	7 (10.9)	22 (7.7)
Blood eosinophil count; BEC (cell/ μ L)	205.4 (48.9-446.2)	199.7 (65.5-384.9)
Blood eosinophil count $\geq$ 300 cell/ μ L, n (%)	28 (43.8)	103 (36.1)

Table 2: Risk Factors of PRISm

Factors	Univariate Analysis		Multivariate Analysis	
	Odds Ratio (95% CI)	P-value	Odds Ratio (95% CI)	P-value
Sex	3.021 (1.638 - 5.569)	<0.001	3.887 (1.771 - 8.530)	0.001
Age	0.986 (0.968 - 1.004)	0.129	0.985 (0.965 - 1.004)	0.138
Smoking	1.375 (0.798 - 2.367)	0.251	2.015 (1.098 - 3.696)	0.024
Weight	1.013 (0.995 - 1.031)	0.142		
Height	0.977 (0.948 - 1.006)	0.132	1.018 (0.977 - 1.060)	0.387
BMI	1.058 (1.009 - 1.111)	0.020		
Obesity (BMI $\geq$ 30)	2.586 (1.374 - 4.864)	0.003	2.428 (1.222 - 4.826)	0.011
Co-morbidities				
Diabetes mellitus	1.012 (0.547 - 1.871)	0.968		
Hypertension	1.324 (0.769 - 2.279)	0.311		
Dyslipidemia	0.990 (0.568 - 1.725)	0.972		

Factors	Univariate Analysis		Multivariate Analysis	
	Odds Ratio (95% CI)	P-value	Odds Ratio (95% CI)	P-value
Impaired fasting glucose	3.454 (0.753 - 15.833)	0.110		
Ischemic heart disease	0.674 (0.148 - 3.067)	0.611		
Congestive heart failure	0.361 (0.046 - 2.828)	0.332		
Atrial fibrillation	1.806 (0.342 - 9.526)	0.486		
Stroke	0.307 (0.039 - 2.38)	0.259		
Allergic rhinitis	1.125 (0.625 - 2.024)	0.694		
Obstructive sleep apnea	4.564 (0.630 - 33.031)	0.133		
Chronic kidney disease	2.168 (0.937 - 5.015)	0.070	2.603 (1.011 - 6.706)	0.047
Cancer	1.468 (0.598 - 3.601)	0.402		
Blood eosinophil count (BEC)	0.999 (0.999 - 1.001)	0.688		
Blood eosinophil count ≥ 300 cell/ μ L (BEC ≥ 300)	1.374 (0.793 - 2.381)	0.257		

Mortality and hospitalization

The relationship between PRISm and clinical outcomes, including mortality, all-cause hospital admissions, cause-specific hospital admissions (Airway, Pneumonia, Ischemic heart disease, and Heart failure), and mortality was analyzed using Spearman's rank correlation. PRISm was significantly related with increased hospital admissions, particularly airway-related admissions, but not with mortality or other disease-specific hospital admissions. This result suggests that PRISm may serve as an early indicator of respiratory morbidity

Table 3: The relationship between PRISm and clinical outcomes

Clinical outcomes	Spearman's rho	p-value	Meaning
Admission	0.126	0.018	PRISm was significantly positively correlated with hospital admission, indicating individuals with PRISm have a higher likelihood of hospital admission
Number of hospitalizations	0.122	0.023	PRISm was significantly positively correlated with the number of hospital admission, indicating individuals with PRISm tended to have a greater number of hospital admissions
Cause of admission			
Airway disease	0.216	0.0001	PRISm showed a significant positive correlation with airway disease-related hospital admissions, with a greater magnitude than the other variables.
Pneumonia	-0.013	0.837	There was no significant correlation
Ischemic heart disease	-0.023	0.745	There was no significant correlation
Heart failure	-0.034	0.558	There was no significant correlation
Dead	0.016	0.717	There was no significant correlation

Discussion

This study highlights the clinical relevance of PRISm as a distinct spirometric pattern that should not be overlooked. In this cohort, the overall prevalence was 9.0% when either definition was used. When using the fixed ratio criteria alone, the prevalence was 8.9%, which is comparable to previous reports such as the Rotterdam study (7.1%) and around 8.5% in the general population.^{5, 6} In contrast, the prevalence decreased to 3.2% when using the LLN criteria, which is also consistent with prior studies.^{5, 6, 10} This difference reflects fewer false-positive cases with the LLN definition, especially in older individuals where lung function naturally declines with age.

In terms of risk factors, the findings were partly similar with previous studies.^{3, 5, 6, 7, 10} Female sex, smoking, and higher BMI were associated with PRISm in this cohort. However, no association was observed with older age or comorbidities such as diabetes, hypertension, or cardiovascular disease; nonetheless, chronic kidney disease was associated with PRISm. This differs from previous reports.^{5, 6, 9, 10} This study was conducted at a single center with a relatively small sample size and a retrospective design. These limitations may have reduced the ability to clearly determine the associations between PRISm and certain factors, compared with findings from previous studies. In addition, the study population consisted of patients who underwent spirometry for clinical reasons rather than from a general population, which could have introduced some selection bias. The lower proportion of patients with cardiovascular comorbidities in this cohort may also have influenced these results.

Regarding clinical outcomes, previous studies have shown that PRISm is associated with

increased cardiovascular events, respiratory events, and mortality.^{5–9,12} In this study, no significant difference in all-cause mortality was observed between the PRISm group and those with normal spirometry, and a significant increase in cardiovascular events was also not observed. However, patients with PRISm had higher rates of hospitalizations, particularly those related to airway diseases. These findings suggest that PRISm may have a greater impact on respiratory morbidity than on cardiovascular outcomes in this setting. The lack of significant associations with mortality and cardiovascular events may be related to the limited number of patients with cardiovascular disease, as well as the retrospective design and absence of longitudinal follow-up. In addition, this hospital-based cohort is subject to selection bias and may limit generalizability, and outcome ascertainment based on ICD-10 codes may be subject to misclassification.

Overall, although some findings differ from previous studies, the overall trend supports that PRISm is not a normal spirometric pattern. Even with preserved FEV1/FVC and FVC, the reduction in FEV1 may reflect underlying disease and be associated with increased clinical burden, particularly in terms of respiratory-related hospitalizations.

Conclusion

PRISm may be an important spirometric abnormality that should not be overlooked. In this study, it was associated with female sex, smoking, obesity, and higher rates of both all-cause and airway disease-related hospitalizations. These findings suggest that patients with PRISm may benefit from closer follow-up, early recognition of disease progression, and timely management to help improve clinical outcomes.

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