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ORIGINAL RESEARCH

The Study of Associated Factors for Non-Tuberculous Mycobacterial Pulmonary Disease Compared to Pulmonary Tuberculosis: A Propensity Score Matching Analysis

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Objective: Investigate the differences in clinical manifestations, imaging features, and associated inflammatory markers between Nontuberculous Mycobacterial Pulmonary Disease (NTM-PD) and Pulmonary Tuberculosis (PTB), identify potential risk factors for NTM-PD, and establish a logistic regression model to evaluate its diagnostic value.

Methods: Baseline data were collected from 145 patients with NTM-PD and 206 patients with PTB. Propensity score matching (PSM) was utilized to achieve a 1:1 match between the two groups, resulting in 103 matched pairs. The differences in comorbidities, imaging features, and inflammatory markers were compared between the two groups. Multivariate binary logistic regression analysis was conducted to identify independent influencing factors, and the diagnostic value of the established model was evaluated.

Results: After matching, significant differences were observed between the NTM-PD group and the PTB group in terms of diabetes, bronchiectasis, chronic obstructive pulmonary disease(COPD), cystic and columnar changes, lung cavity presentation, and monocyte percentage (MONO%), lymphocyte count (LYMPH#), platelet-to-lymphocyte ratio (PLR), and lymphocyte-to-monocyte ratio (LMR) ($P<0.05$). Logistic regression analysis confirmed that diabetes, bronchiectasis, COPD, and lung cavities were risk factors for NTM-PD. The established regression analysis model was analyzed by the Receiver Operating Characteristic (ROC) curve, the Area Under the Curve (AUC) was obtained as 0.795 ($P<0.001$, 95% CI 0.734–0.857). At a Youden index of 0.505, the sensitivity was 84.5% and the specificity was 66.6%. The Hosmer-Lemeshow test was used to evaluate the model's calibration, with a chi-square value of 11.023 and $P=0.200>0.05$, indicating no significant difference between predicted and observed values.

Conclusion: For patients without diabetes but with bronchiectasis, COPD, and imaging characteristics of lung cavities, a high level of vigilance and active differential diagnosis for NTM-PD should be exercised. Given that the clinical manifestations of NTM-PD are similar to those of PTB, a detailed differential diagnosis is necessary during the diagnostic process to avoid misdiagnosis.

Keywords: nontuberculous mycobacterial pulmonary disease, pulmonary tuberculosis, propensity score matching

Introduction

Non-tuberculous Mycobacteria (NTM) encompass over 190 discrete species distinct from *Mycobacterium tuberculosis* and *Mycobacterium leprae*, ubiquitously present in the natural environment within air, soil, dust, plant material, and water resources.[1,2] NTM infections commonly manifest as pulmonary disease, characterized by symptoms akin to those seen in pulmonary tuberculosis, such as cough, sputum production, hemoptysis, and persistent low-grade fevers, which can complicate early differential diagnosis, particularly when coexistent with chronic cough, sputum production, and bronchiectasis, potentially leading to misidentification as bronchial tuberculosis.[3] Globally, NTM-Pulmonary Disease (NTM-PD) has demonstrated an ascending incidence trend,[4–7] contributing to increased disease prevalence and imposing substantial challenges on healthcare systems worldwide, concurrently exacerbating socioeconomic pressures.[4,8,9] In China, the estimated incidence of tuberculosis is 748,000 patients, with an incidence rate of 52/100,000.[10] A survey

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based on antimicrobial bacillus smear-positive patients in 17 tuberculosis designated hospitals across the country suggests that the percentage of NTM is 6.8%.[11] Despite the reliance on microbiological culture positivity, supported by histopathological or acid-fast bacillus microscopic evidence, as the fundamental basis for NTM-PD diagnosis, this diagnostic pathway is fraught with complexities and practical challenges. Clinicians may undervalue the likelihood of NTM pulmonary infections during preliminary evaluations, exacerbated by issues surrounding sample contamination during sputum collection and processing, and the protracted incubation periods for NTM cultures. Such obstacles often obfuscate the genuine identity of NTM lung disease, culminating in frequent misdiagnoses as tuberculosis or alternative respiratory conditions, thereby delaying precise diagnosis and timely interventions. Moreover, instances where NTM-PD is mistaken for drug-resistant tuberculosis could precipitate disease progression or prove fatal due to the failure to initiate efficacious NTM-specific therapies.[12] To bolster the precision of NTM-PD identification and expedite optimal treatment pathways, it is imperative to explore potential risk factors inclusive of clinical symptomatology, radiological features, and accompanying laboratory inflammatory markers. This study undertakes a retrospective analysis of hospitalized NTM-PD and Pulmonary Tuberculosis (PTB) patients, scrutinizing pertinent factors and inflammatory marker data with the objective of elucidating more definitively the potential risk factors for NTM-PD, ultimately informing enhanced clinical diagnostic and therapeutic protocols.

Materials and Methods

Study Subjects

The study cohort comprised 145 patients diagnosed with NTM-Pulmonary Disease (NTM-PD) and 206 individuals with Pulmonary Tuberculosis (PTB), who were hospitalized and managed at Fuyang Second People's Hospital between January 2021 and December 2023, stratified into NTM-PD and PTB groups, respectively. Throughout the course of this research, all procedures strictly adhered to the principles outlined in the Declaration of Helsinki and its subsequent amendments, thereby warranting the ethical and legal legitimacy of the study conduct.

Inclusion and Exclusion Criteria

Inclusion Criteria: (1) Participants diagnosed with NTM-Pulmonary Disease (NTM-PD) fulfilling the diagnostic criteria detailed in the "Guidelines for the Diagnosis and Treatment of Non-tuberculous Mycobacterial Diseases (2020 Edition)";[13] (2) Individuals diagnosed with Pulmonary Tuberculosis (PTB) according to the "WS288—2017 Diagnostic Criteria for Pulmonary Tuberculosis";[14] (3) Patients with a confirmed positive etiology and a complete set of medical records; (4) Those who were identified as having either NTM-PD or PTB through culture-based identification tests during hospital admission. Exclusion Criteria: (1) Patients with severe psychiatric comorbidities, active malignancies, or HIV-positive serostatus; (2) Participants concurrently diagnosed with both NTM-PD and PTB.

Patients Data Collection

Clinical data of the patients (including gender, age, occupation, Body Mass Index (BMI), smoking history, alcohol consumption history, chronic disease history, various comorbidities, clinical manifestations, etc)., imaging features (patchy, nodular, cystic and columnar, linear, ground-glass, honeycombed, flocculent), and laboratory inflammatory markers were collected.

Case Grouping

Patients were stratified into two distinct cohorts: the NTM-Pulmonary Disease (NTM-PD) group and the Pulmonary Tuberculosis (PTB) group.

Clinical Laboratory Data

The Hitachi 7600 Automated Biochemistry Analyzer was utilized for the quantitative assessment of C-reactive protein (CRP) and Serum Amyloid A (SAA) concentrations in blood samples, while the SYSMEX XE2100 Fully Automated Hematology Analyzer was employed to enumerate and quantify a variety of hematological parameters, which included:

White Blood Cell Count (WBC), Neutrophil Percentage (NEUT%), Lymphocyte Percentage (LYMPH%), Monocyte Percentage (MONo%), Absolute Neutrophil Count (NEUT#), Absolute Lymphocyte Count (LYMPH#), Absolute Monocyte Count (MONo#), and Platelet Count (PLT). Utilizing these measurements, several ratios were computed, namely the SAA-to-CRP ratio (SAA/CRP), Neutrophil-to-Lymphocyte Ratio (NLR), Platelet-to-Lymphocyte Ratio (PLR), and Lymphocyte-to-Monocyte Ratio (LMR). All procedures were meticulously executed in strict adherence to the manufacturer's instructions detailed within the respective assay kit manuals.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics version 26.0 software. Continuous variables underwent Normality testing utilizing the Kolmogorov–Smirnov (K-S) test. For those demonstrating a Normal distribution, comparisons between two independent samples were executed using an independent-samples *t*-test and are reported as mean ± standard deviation (mean±SD). Conversely, non-Normally distributed continuous variables were subjected to the Mann–Whitney *U*-test and are presented as [median(M) (interquartile range: P25, P75)]. Categorical data are expressed in terms of frequency (n) and percentage (%) and were analyzed utilizing chi-square (χ^2) tests. When the theoretical frequency (T) was less than 5 or over 20% of Ts were below 1, Fisher's exact test was employed instead. Propensity score matching (PSM) was employed to match the patients in the two groups using a 1:1 nearest neighbor method with a caliper value of 0.02. NTM-PD status was used as the dependent variable, and 12 potential confounding factors, including gender, age, BMI, occupation, coughing, sputum production, hemoptysis, dyspnea, loss of appetite, fever, smoking history, and alcohol consumption history, were included as covariates for the matching process. A multivariate binary logistic regression model was constructed, and the receiver operating characteristic (ROC) curve was used to calculate the area under the curve (AUC) to assess the predictive value of the model. The Hosmer-Lemeshow (HL) test was employed to evaluate the model's calibration. A P-value of less than 0.05 was considered statistically significant.

Results

Comparison of Baseline Characteristics Before and After Matching Between the Two Groups

A comparative analysis of clinical characteristics was conducted between the two groups. Before matching, significant differences were observed in age, gender, BMI, occupation, dyspnea, loss of appetite, fever, smoking history, and alcohol consumption history ($P<0.05$). Coughing, sputum production, and hemoptysis did not show statistically significant differences ($P>0.05$). A total of 103 pairs of subjects were successfully matched, and there were no statistically significant differences in the characteristic factors between the two groups after matching ($P>0.05$) (Table 1). The propensity score distribution plots showed that the distribution was uneven before matching, but the differences significantly reduced post-matching, achieving substantial balance (Figure 1).

Comparative Analysis of Related Factors Between the Two Groups After Matching

A comparative analysis of comorbidities, imaging features, and inflammatory markers was conducted between the two groups after matching. The results revealed significant differences in diabetes, bronchiectasis, COPD, cystic-columnar, lung cavities, MONO%, LYMPH#, PLR, and LMR ($P<0.05$). No statistically significant differences were found in the other factors ($P>0.05$) (Table 2).

Multivariate Binary Logistic Regression Analysis

The factors of diabetes, bronchiectasis, COPD, cystic-columnar, and lung cavities were categorized into binary values (Table 3). Using NTM-PD status as the dependent variable and diabetes, bronchiectasis, COPD, cystic and columnar changes, lung cavities, MONO%, LYMPH#, PLR, and LMR as covariates, a multivariate binary logistic regression analysis was conducted. The results showed that diabetes, bronchiectasis, COPD, and lung cavities were statistically significant ($P<0.05$), while the other factors were not statistically significant ($P>0.05$) (Table 4).

Table 1 Comparison of Baseline Characteristics Before and After Propensity Matching Between the Two Groups

Characteristic	Before Propensity Score Matching			After Propensity Score Matching		
	NTM-PD (n=145)	PTB (n=206)	*P value*	NTM-PD (n=103)	PTB (n=103)	*P value*
Age[M(P25, P75)]	68 (59,75)	59.5 (44.75,71)	<0.001	66 (57,73)	55.5 (32.0,67.5)	0.952
Gender[n(%)]			0.034			0.358
Male	94 (64.83)	155 (75.24)		70 (67.96)	76 (73.79)	
Female	51 (35.17)	51 (24.76)		33 (32.04)	27 (26.21)	
BMI (mean±SD)	18.71±2.70	20.41±3.50	<0.001	19.22±2.72	19.20±3.22	0.963
Occupation[n(%)]			0.010[a]			0.792[a]
Peasants	128 (88.28)	154 (74.76)		88 (85.44)	87 (84.47)	
Clerk/Office Worker	7 (4.83)	18 (8.74)		7 (6.80)	6 (5.83)	
Retiree	5 (3.45)	7 (3.40)		3 (2.91)	5 (4.85)	
Student	0 (0.00)	7 (3.40)		0 (0.00)	1 (0.97)	
Freelancer	5 (3.45)	20 (9.71)		5 (4.85)	4 (3.88)	
Coughing[n(%)]	135 (93.10)	181 (87.86)	0.107	96 (93.20)	97 (94.17)	0.774
Sputum production[n(%)]	129 (88.97)	169 (82.04)	0.353	90 (87.38)	90 (87.38)	1.000
Hemoptysis[n(%)]	28 (19.31)	31 (15.05)	0.293	17 (16.50)	20 (19.42)	0.586
Dyspnea[n(%)]	92 (63.45)	74 (35.92)	<0.001	55 (53.40)	57 (55.34)	0.780
Loss of appetite[n(%)]	77 (53.10)	60 (29.13)	<0.001	43 (41.75)	47 (45.63)	0.574
Fever[n(%)]	75 (51.72)	77 (37.38)	0.008	46 (44.66)	47 (45.63)	0.889
Smoking history[n(%)]	52 (35.86)	96 (46.60)	0.045	40 (38.83)	48 (46.60)	0.260
Alcohol consumption history[n(%)]	35 (24.14)	76 (36.89)	0.011	27 (26.21)	31 (30.10)	0.535

Note: [a]Fisher's exact test was employed.

The Predictive Validity and Calibration of the Logistic Regression Model Were Assessed

The multivariate binary logistic regression analysis model was subjected to ROC curve analysis. The results indicated an AUC of 0.795 (P<0.001, 95% CI 0.734–0.857). At a Youden index of 0.505, the sensitivity was 84.5% and the specificity was 66.6% (Figure 2). The Hosmer-Lemeshow (HL) test was used to evaluate the model's calibration, yielding a chi-square value of 11.023 and P=0.200>0.05 (Figure 3).

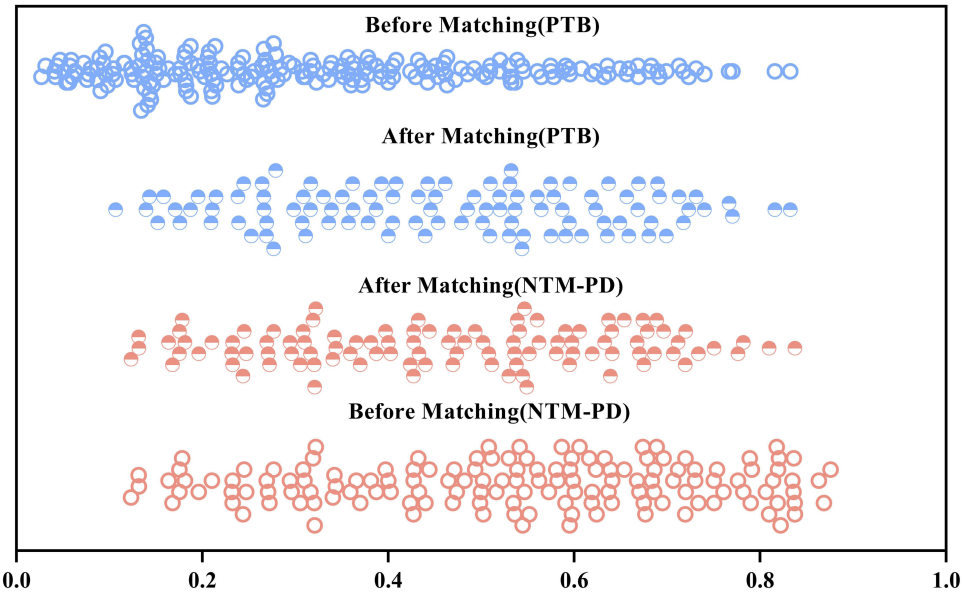

Figure 1 Distribution of scores before and after matching in the two groups.

Table 2 Comparative Analysis of Related Factors Between the Two Groups After Matching

Variables	NTM-PD	PTB	Statistical value	*P value*
Diabetes[n(%)]	9 (8.74)	25 (24.27)	9.018	0.003
Hypertension[n(%)]	13 (12.62)	17 (16.50)	0.624	0.429
Bronchiectasis[n(%)]	30 (29.13)	10 (9.71)	12.410	<0.001
Emphysema[n(%)]	12 (11.65)	9 (8.74)	0.477	0.490
COPD[n(%)]	25 (24.27)	11 (10.68)	6.597	0.010
Patchy[n(%)]	90 (87.38)	94 (91.26)	0.714	0.367
Nodular[n(%)]	45 (43.69)	59 (57.28)	3.806	0.051
Cystic-columnar[n(%)]	14 (13.59)	4 (3.88)	6.087	0.014
Linear[n(%)]	42 (40.78)	36 (34.95)	0.743	0.389
Ground-glass[n(%)]	3 (2.91)	2 (1.94)	–[a]	1.000
Honeycomb[n(%)]	7 (6.80)	2 (1.94)	–[a]	0.170
Fibrotic[n(%)]	1 (0.97)	0 (0.00)	–[a]	1.000
Lung cavitation[n(%)]	72 (69.90)	48 (46.60)	11.498	0.001
CRP[M(P25, P75)]	25.10 (7.00,61.70)	32.80 (9.30,32.80)	−0.937	0.349
SAA[M(P25, P75)]	58.40 (13.80,149.80)	68.00 (26.30,68.00)	−0.39	0.696
WBC[M(P25, P75)]	6.80 (5.59,9.04)	7.06 (4.94,7.06)	−0.582	0.561
NEUT%[M(P25, P75)]	67.50 (58.20,74.40)	66.90 (60.00,66.90)	−0.726	0.468
LYMPH%[M(P25, P75)]	20.90 (13.80,28.30)	19.80 (11.80,19.80)	−1.393	0.164
MONO%[M(P25, P75)]	8.70 (7.10,12.10)	10.10 (8.30,10.10)	−2.604	0.009
NEUT#[M(P25, P75)]	4.47 (3.29,6.55)	4.55 (3.00,4.55)	−0.233	0.816
LYMPH#[M(P25, P75)]	1.49 (0.96,1.88)	1.20 (0.91,1.20)	−2.121	0.034
MONO#[M(P25, P75)]	0.63 (0.45,0.85)	0.72 (0.51,0.72)	−1.333	0.183
PLT[M(P25, P75)]	253.00 (198.00,332.00)	261.00 (204.00,261.00)	−0.482	0.63
SAA/CRP[M(P25, P75)]	2.12 (1.14,4.61)	2.00 (0.92,2.00)	−0.482	0.63
NLR[M(P25, P75)]	3.19 (2.05,5.10)	3.48 (2.18,3.48)	−1.154	0.249
PLR[M(P25, P75)]	183.54 (130.71,268.25)	209.30 (141.35,209.30)	−2.126	0.034
LMR[M(P25, P75)]	2.39 (1.69,3.08)	1.70 (1.18,1.70)	−2.952	0.003

Note: [a]Fisher's exact test was employed.

Table 3 Variable Coding Table

Independent Variable	Assign	Independent Variable	Assign
Diabetes	No=0;Yes=1	Bronchiectasis	No=0;Yes=1
COPD	No=0;Yes=1	Cystic-columnar	No=0;Yes=1
Lung cavitation	No=0;Yes=1		

Table 4 Multivariate Binary Logistic Regression Analysis

Variable	β	SE	Wald χ^2	*P value*	OR	95% CI	
						Lower Limit	Upper Limit
Diabetes	−1.485	0.474	9.831	0.002	0.227	0.090	0.573
Bronchiectasis	1.200	0.486	6.096	0.014	3.322	1.281	8.614
COPD	0.916	0.453	4.099	0.043	2.500	1.030	6.068
Cystic-columnar	0.393	0.712	0.304	0.581	1.481	0.367	5.974
Lung cavitation	1.356	0.349	15.081	<0.001	3.882	1.958	7.696
MONO%	−0.045	0.053	0.730	0.393	0.956	0.861	1.061
LYMPH#	−0.061	0.389	0.025	0.875	0.941	0.439	2.018
PLR	−0.003	0.002	2.011	0.156	0.997	0.994	1.001
LMR	0.233	0.217	1.154	0.283	1.262	0.825	1.930

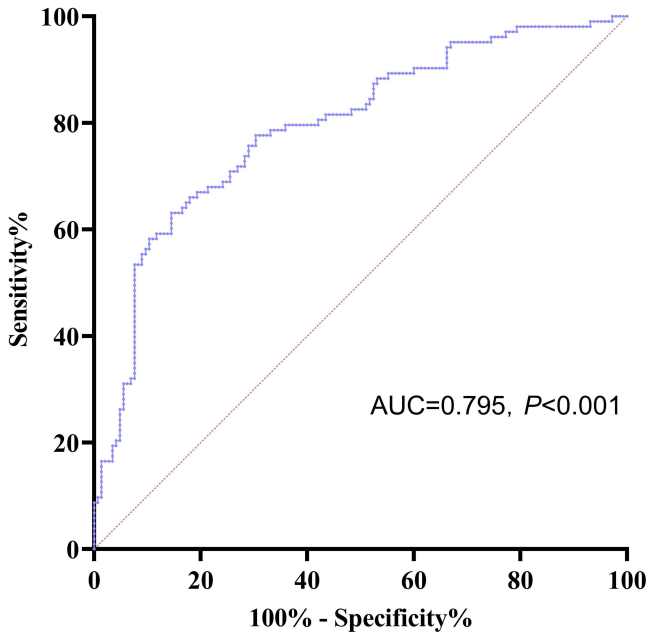

Figure 2 Multifactor binary logistic regression analysis model ROC curve.

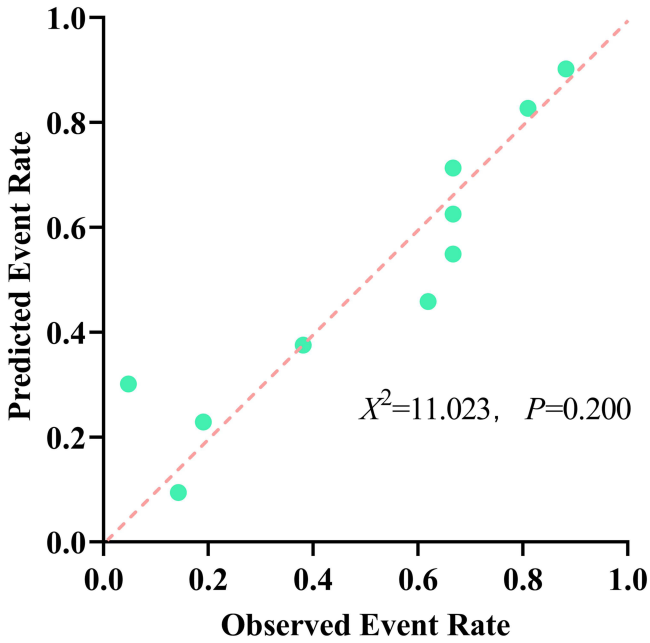

Figure 3 Calibration of multifactor binary logistic regression analysis model.

Discussion

China stands as one of the countries with a high burden of pulmonary tuberculosis, occupying the third position globally in terms of incidence rates.[15] The substantial clinical overlap between NTM-PD and PTB, presenting with overlapping symptoms like cough, sputum production, intermittent fever, night sweats, and hemoptysis, as well as shared radiographic characteristics on chest Computed Tomography (CT) scans, such as patchy infiltrates, nodular lesions, and even calcifications, significantly augments the intricacy of differentiating between these two entities. Furthermore, the presence of a multitude of primary healthcare facilities across China, coupled with an inconsistent distribution of medical

resources and a variable spectrum of technical competencies, results in numerous grassroots institutions being unable to perform efficient NTM cultures or Polymerase Chain Reaction (PCR) tests. This confluence of factors exacerbates the existing challenges in accurate diagnosis of NTM-PD. Thus, a proportion of genuine NTM-PD cases may inadvertently be misclassified as pulmonary tuberculosis during primary care stages.

Presently, research endeavors pertaining to NTM-PD and PTB predominantly adopt a retrospective design, with a multitude of studies investigating risk factors associated with both diseases. Nevertheless, the robustness of research findings is frequently undermined by imbalances and biases inherent in the baseline characteristic data across different cohorts. Notably, clinical manifestations such as coughing, sputum production, fever, and dyspnea are prevalent in both NTM-PD and PTB, thereby complicating the distinction between whether these variables serve as confounders or direct causative agents, even when intergroup differences exist. Furthermore, factors like age and gender, known to be strongly associated with tuberculosis, can also obscure the identification of risk factors. To attenuate the influence of specific confounding elements, this study effectively employed a 1:1 propensity score matching (PSM) technique to match 103 patient pairs from a total pool of 351 patients, thus attaining equilibrium in the baseline characteristic data across the comparative groups.

This study showed that after matching, there were significant differences between the two groups in comorbidities, imaging features, and inflammatory markers, including diabetes, bronchiectasis, COPD, cystic and columnar changes, lung cavities, MONO%, LYMPH#, PLR, and LMR. In comparison with PTB patients, those diagnosed with NTM-PD exhibit a lower prevalence of diabetes mellitus, a finding potentially explained by an association of NTM infection with specific immunological milieus rather than diabetes perse directly augmenting vulnerability, Unlike tuberculosis, NTM infections appear to have a predilection for occurrence in populations characterized by relatively intact immune function yet concurrently affected by other chronic pulmonary disorders;The prevalence of bronchiectasis and COPD is notably elevated among NTM-PD patients relative to PTB patients. Such pre-existing pulmonary pathologies may engender a decline in local defense mechanisms and compromised respiratory clearance capabilities, rendering NTM more prone to persistence and proliferation along the bronchial epithelium, consequently predisposing or exacerbating NTM-PD. This observation aligns with prior findings reported by several domestic and international scholars;[16–20] In NTM-PD patients, the imaging hallmarks of lung disease, such as cystic and columnar changes, along with the development of lung cavities, are more frequently observed. This phenomenon might be attributed to the distinct chronic inflammatory responses, tissue degradation, and reparative processes instigated by NTM infections. NTM infections have a greater propensity to engender complex, cystic, or cavity-like structural lung impairments. The cavities arising in NTM-related lung disease often manifest multi-focal, irregular, or multi-layered attributes, whereas those seen in pulmonary tuberculosis are more commonly associated with satellite lesions or well-defined margins;LYMPH# and LMR were significantly higher in the NTM-PD group compared to the PTB group, whereas MONO% was significantly lower in the NTM-PD group than in the PTB group, which could potentially be attributed to the chronic inflammatory response in NTM-PD predominantly characterized by monocyte and lymphocyte infiltration. Conversely, the PLR values in the NTM-PD group were significantly diminished compared to those in the PTB group, possibly reflecting a milder chronic inflammatory response and less pronounced effect on platelet activation in NTM-PD;Of note, within the current study, while no significant discrepancies were observed in the levels of CRP and SAA between the two patient groups, both parameters were notably elevated above their respective normal ranges, indicative of substantial inflammatory activity in both cohorts. However, these biomarkers failed to discriminate the specificity of the two diseases, a finding discordant with previous investigations by Getahun H and Zhang Y,[21,22] but concordant with the report by He HQ.[23] This disparity underscores the variability in literature regarding inflammatory indices, necessitating additional large-scale studies to substantiate these observations.

This study successfully developed a logistic regression model for the diagnosis of NTM-PD. Multivariate regression analysis was employed to evaluate the effects of diabetes mellitus, bronchiectasis, COPD, cystic and columnar changes, lung cavitation, MONO%, LYMPH#, PLR, and LMR on the outcome variable (NTM-PD). It identified diabetes mellitus as a protective factor and bronchiectasis, COPD, and lung cavitation as risk factors for NTM-PD, thereby constituting a predictive model. The area under the receiver operating characteristic curve (AUC) for discriminating NTM-PD was 0.795, denoting a high discriminative capacity of the model. The absence of a statistically significant difference between the predicted and actual incidences indicated that the model demonstrated satisfactory calibration and could objectively and accurately distinguish NTM-PD from PTB.

Limitations

This study acknowledges several inherent limitations. Although PSM is widely used to reduce bias in observational studies, it is not without limitations. Our study may have been impacted by some of the inherent limitations of the PSM methodology, which may have contributed to the emergence of some unexpected results, particularly the finding that diabetes serves as a protective factor. PSM aims to reduce bias by balancing covariates between the treatment and control groups; however, not all potential confounders may be completely eliminated in this process. In particular, unmeasured or unknown confounding variables may still exert an influence on the results. Furthermore, the construction and selection of PSM models can exhibit some sensitivity to the outcome, potentially impacting the robustness of the findings. In addition, the modest sample size coupled with the room for improvement in the precision of the methodologies used may not entirely eliminate all potential confounding variables. The conclusions drawn herein might be influenced by temporal and environmental context-specific constraints, thereby imparting a degree of temporality and variability. To surmount these drawbacks, there is a necessity to enlarge the research sample size and implement more exhaustive data acquisition strategies. Concomitantly, future research endeavors are expected to validate and further expound upon the current findings.

Conclusion

In conclusion, the logistic regression model constructed utilizing the four identified independent variables—absence of diabetes, presence of bronchiectasis, chronic obstructive pulmonary disease (COPD), and lung cavities—exhibits a clinically relevant discriminatory power for distinguishing NTM-PD from PTB.

Data Sharing Statement

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Ethics Approval

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the Second People's Hospital of Fuyang City (approval number: 20211231014). Due to the retrospective nature of the study, the need for informed consent was waived and waiver was approved by the Ethics Committee of the Second People's Hospital of Fuyang City. All patient data were handled in strict accordance with ethical standards, ensuring confidentiality and anonymity. No personal identifiers were used in the analysis or reporting of the study results.

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Disclosure

The authors report no potential conflicts of interest in this work.

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