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ORIGINAL RESEARCH

Associations of Platelet to High-Density Lipoprotein Cholesterol Ratio with Chronic Obstructive Pulmonary Disease: A Cross-Sectional Study from the US National Health and Nutrition Examination Survey

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Background: The platelet to high-density lipoprotein cholesterol ratio (PHR) is a novel biomarker for inflammation and hypercoagulability. This study aimed to explore the potential association between PHR and prevalence of chronic obstructive pulmonary disease (COPD).

Methods: Participants aged between 40 and 85 years from the 1999–2018 US National Health and Nutrition Examination Survey with COPD were included. Multivariable logistic regression and restricted cubic spline analysis were applied to evaluate the associations between PHR and COPD. Propensity score matching (PSM) was performed to reduce the impact of potential confounding factors.

Results: A total of 25751 participants, including 753 with COPD, at a mean age of 57.19 years and 47.83% men, were included. The multivariable-adjusted model showed that the odds ratio (OR) and 95% confidence interval (CI) for PHR to predict COPD was 1.002 (1.001–1.003). Compared with the lowest quartile, the ORs and 95% CIs for the Q2, Q3, and Q4 PHR quartile were 1.162 (0.874–1.546), 1.225 (0.924–1.625), and 1.510 (1.102–2.069), respectively (P for trend = 0.012). Restricted cubic spline analysis demonstrated a linear association between PHR and COPD prevalence both before and after PSM. Significant association between PHR and COPD prevalence was observed only in participants without hypertension. Receiver-operating characteristic curves showed significantly higher area under the curve for distinguishing COPD from non-COPD by PHR than platelet count and high-density lipoprotein cholesterol.

Conclusion: PHR is significantly associated with COPD prevalence in US adults aged 40 to 85 years without hypertension, supporting the effectiveness of PHR as a potential biomarker for COPD.

Keywords: chronic obstructive pulmonary disease, high-density lipoprotein cholesterol, NHANES, platelet, platelet/HDL ratio

Introduction

Chronic obstructive pulmonary disease (COPD) is a common chronic and debilitating inflammatory condition of the airways clinically characterized by respiratory symptoms and irreversible airflow limitation. Epidemiologic studies suggest that COPD is associated with significant morbidity and mortality, with a total of 3.3 million deaths reported in 2019, which is expected to increase to 4.5 million in 2030.[1] Although the exact pathogenesis of COPD remains largely unknown, mounting evidence suggests that unrelenting inflammation, both from environmental exposures and smoking, plays an indispensable role in its pathogenesis.[2] For example, C-reactive protein, a frequently used biomarker of inflammation, has previously been shown to be correlated with COPD severity and to predict mortality risk.[3]

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Platelets have been identified as crucial modulators of inflammatory responses and contribute to the development of COPD through multiple mechanisms, including modulation of the hypoxia signaling pathway and breakdown of lung elastin by platelet factor 4.[4] In addition, platelets have also been shown to contribute to COPD by mediating immune responses and thrombotic pathways.[5] However, the high-density lipoprotein (HDL) cholesterol has been shown to possess antiplatelet, anti-thrombotic, and anti-inflammatory properties.[6] Previous studies have yielded conflicting results regarding HDL levels in patients with COPD.[7] The platelet/HDL ratio (PHR), a novel biomarker that may reflect the balancing role of platelets and HDL for inflammation and hypercoagulability, was first proposed by Jialal's group as a valid biomarker for nascent metabolic syndrome.[8] Subsequent studies have also indicated that PHR is associated with several conditions, such as nephrolithiasis and non-alcoholic fatty liver disease.[9,10] The study by Zhang et al showed that a PHR greater than 223.684 is positively associated with the prevalence of stroke, and PHR is linearly indicative of cardiovascular mortality in patients with stroke.[11] However, there is a paucity of data regarding the association between PHR and COPD prevalence.

Therefore, the aim of the present study was to examine the association between PHR and COPD prevalence using cross-sectional data from the US National Health and Nutrition Examination Survey (NHANES) and death certificate data linked to the National Death Index.

Methods

Data Source and Subjects

The NHANES is a nationwide survey that was conducted every 2 years to collect information about the health and nutritional status of the non-institutionalized US population. The data were collected through face-to-face interviews, physical examinations, and laboratory tests. The detailed survey protocol is recorded and readily available on the website: https://wwwn.cdc.gov/nchs/nhanes/Default.aspx. The NHANES study was approved by the Institutional Review Board of the National Center for Health Statistics, and informed consent was obtained from all adult participants. According to the national legislation, ethical approval for medical researches involving human subjects can be waived if the research uses publicly available data with an observational design or uses anonymized data (https://www.gov.cn/zhengce/zhengceku/2023-02/28/content_5743658.htm). This study used publicly available NHANES data and all the identifying information in NHANES has been de-identified, so ethical approval was exempted by the Ethics Committee of the Shanghai Tenth Hospital.

In this study, we used the NHANES data across 10 cycles of the survey from 1999–2018. Subjects aged between 40 and 85 years were included. Exclusion criteria were pregnancy (n = 32), missing data on COPD (n = 77), missing data on complete blood count or HDL level (n = 4016), and incomplete data on other covariates (n = 6376). The final analytic sample included 25751 participants with complete data on the primary exposure and the outcome. The detailed process of participant selection and exclusion is shown in Figure 1.

Criteria for COPD

Participants were considered to have COPD if responded yes to the question "Has a doctor or other health professional ever told you that you had COPD?". This definition was in accordance with previous studies in terms of COPD.[12,13]

Blood Lipids and Cell Count Determination

Venous blood samples were collected after an overnight fast for at least 9 hours. The HDL concentrations were measured using the direct precipitation or immunoassays. The PHR was calculated as the ratio of the platelet count (10^3 cells/μL) to the HDL concentration (mg/dL).[9–11]

Covariates

Covariates indicate factors that are relevant or potentially confounding according to existing literature and clinical judgment. In this study, the following covariates information were collected. Participants' socioeconomic and demographics, including age (continuous), sex (male/female), race (non-Hispanic white, non-Hispanic black, Mexican American, other Hispanic, and other races), marital status (single, nonsingle), education level (< high school, high

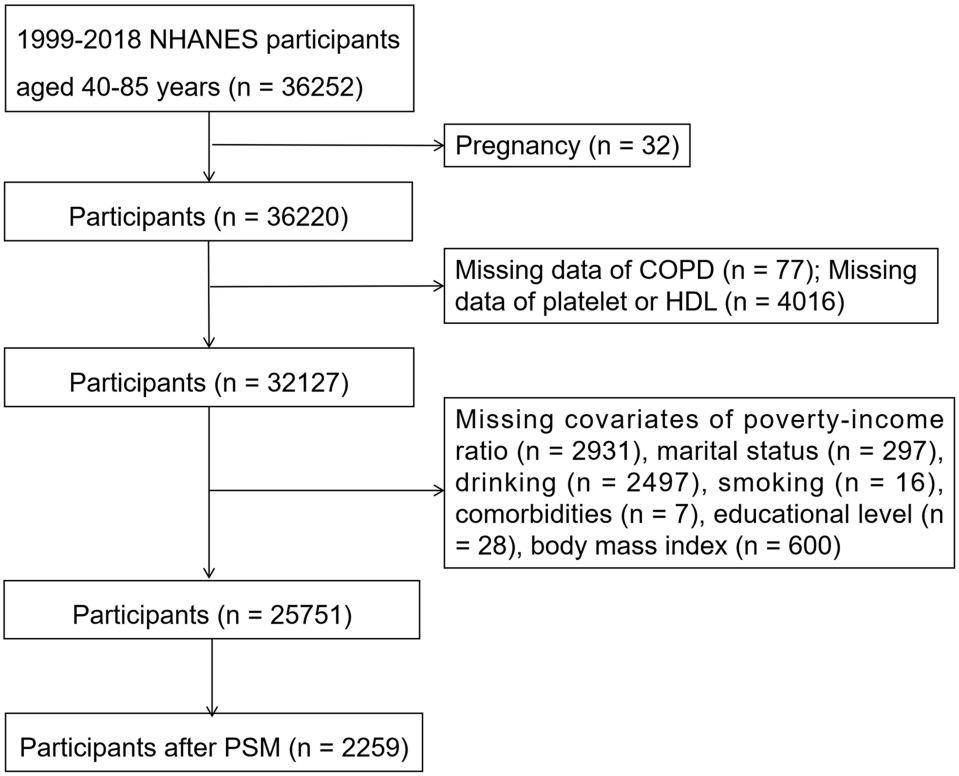

Figure 1 Study flowchart showing the process of participants inclusion and exclusion.
Abbreviation: PSM, propensity score matching.

school, and > high school), and poverty–income ratio were collected at the time of the questionnaire. In addition, physical measures and lifestyle factors, including smoking status (never, former, current), use of alcohol (never, former, mild, moderate, and heavy), and body mass index (BMI), were also obtained. The detailed criteria for categorizing smoking and alcohol consumption were consistent with those previously reported.[14] Information on concurrent cardiovascular disease, including angina, myocardial infarction, coronary heart disease, congestive heart failure, and stroke, was also acquired via questionnaire. Kidney function assessment with estimated glomerular filtration rate was calculated based on serum creatinine.[15]

Statistical Analysis

All the statistical analyses were weighted to account for the complex, multistage, probability sampling design of NHANES and to obtain nationally representative estimates. Variables were expressed as means ± standard errors or counts (weighted percentages) and compared using the independent Student's *t*-test or Chi-Squared test, as appropriate. To minimize the impact of confounding variables between the 2 groups, a 1:2 propensity score-matching (PSM) for participants' age, sex, and race was performed. Binary logistic regression was used to estimate the association between PHR and COPD prevalence. During this process, the odds ratio (OR) and 95% confidence interval (CI) were calculated. In addition, this association was also analyzed based on PHR quartiles, with the lowest Q1 as the reference group. Three models in total were constructed: the crude model was unadjusted; model 1 was adjusted for age, sex, race, marital status, education level, and poverty–income ratio; and the model 2 was further adjusted for body mass index, drinking, smoking, and comorbidities of hypertension, diabetes, and cardiovascular diseases. Restricted cubic spline analysis with fully adjusted logistic regression was used to determine the dose–response associations between PHR and COPD risk. Stratified analysis was performed to test whether the relationship between PHR and COPD risk differed by age, sex, race, hypertension, and diabetes. Receiver-operating characteristic (ROC) curves were generated to determine and

compare the capabilities of platelet counts, HDL, and PHR for distinguishing COPD from non-COPD. Two-tailed $P<0.05$ denoted statistical significance.

Results

Baseline Participant Characteristics

A total of 25751 participants, including 753 with COPD and 24998 without COPD, with a mean age of 57.19 years and 47.83% men, were included. As shown in Table 1, individuals with COPD exhibited significantly higher age, a higher prevalence of non-Hispanic white and single status, less educational attainment, a lower poverty–income ratio, and a higher prevalence of smoking and medical comorbidities of hypertension, diabetes, and cardiovascular disease. In terms of laboratory tests, participants with COPD had significantly lower estimated glomerular filtration rate and higher PHR than participants without COPD. After PSM, the age difference between the COPD group and the non-COPD group was drastically reduced, and there were no longer any significant differences in race/ethnicity composition, diabetes prevalence, and estimated glomerular filtration rate between the two groups.

Table 1 Characteristics of Study Participants Before and After Propensity Score Matching

	Before Propensity Score Matching				After Propensity Score Matching			
	Total	**Non-COPD**	**COPD**	**P value**	**Total**	**Non-COPD**	**COPD**	**P value**
n (unweighted)	25751	24,998	753		2259	1506	753	
N (weighted)	106950949	104,143,606	2,807,343		9,525,507	6,718,164	2,807,343	
Age, years	57.19±0.15	56.98±0.15	64.98±0.44	< 0.001	63.88±0.28	63.42±0.35	64.98±0.44	0.006
Sex (n, %)				0.064				0.271
Male	12822(47.83)	12,367(47.72)	455(51.94)		1363(54.02)	908(54.89)	455(51.94)	
Female	12929(52.17)	12,631(52.28)	298(48.06)		896(45.98)	598(45.11)	298(48.06)	
Race (n, %)				< 0.001				0.16
Non-Hispanic White	12705(75.56)	12,166(75.30)	539(84.94)		1619(86.99)	1080(87.85)	539(84.94)	
Non-Hispanic Black	5058(9.21)	4971(9.34)	87(4.72)		259(4.26)	172(4.06)	87(4.72)	
Mexican American	4114(5.61)	4075(5.73)	39(1.28)		117(1.05)	78(0.96)	39(1.28)	
Other Hispanic	1973(4.20)	1932(4.25)	41(2.41)		121(2.55)	80(2.61)	41(2.41)	
Other	1901(5.43)	1854(5.39)	47(6.66)		143(5.15)	96(4.52)	47(6.66)	
Marital status (n, %)				< 0.001				< 0.001
Non-single	16337(68.83)	15,950(69.21)	387(54.82)		1372(65.33)	985(69.72)	387(54.82)	
Single	9414(31.17)	9048(30.79)	366(45.18)		887(34.67)	521(30.28)	366(45.18)	
Education level (n, %)				< 0.001				< 0.001
< High school	3513(6.16)	3362(5.94)	151(14.49)		332(7.65)	181(4.79)	151(14.49)	
High school	9605(34.80)	9244(34.40)	361(49.67)		943(40.12)	582(36.13)	361(49.67)	
> High school	12633(59.04)	12,392(59.66)	241(35.85)		984(52.23)	743(59.08)	241(35.85)	
Poverty–income ratio	3.24±0.03	3.27±0.03	2.20±0.08	< 0.001	2.92±0.05	3.21±0.06	2.20±0.08	< 0.001
BMI, kg/m^2	29.24±0.07	29.26±0.07	28.65±0.39	0.119	28.94±0.18	29.06±0.21	28.65±0.39	0.357

(*Continued*)

Table 1 (Continued).

	Before Propensity Score Matching				After Propensity Score Matching			
	Total	**Non-COPD**	**COPD**	**P value**	**Total**	**Non-COPD**	**COPD**	**P value**
Drinking (n, %)				< 0.001				< 0.001
Never	3778(11.27)	3726(11.40)	52(6.28)		278(10.95)	226(12.90)	52(6.28)	
Former	5680(18.28)	5374(17.74)	306(38.40)		717(26.74)	411(21.86)	306(38.40)	
Mild	9360(40.45)	9139(40.76)	221(29.07)		830(39.83)	609(44.33)	221(29.07)	
Moderate	3377(15.69)	3301(15.78)	76(12.50)		223(12.75)	147(12.86)	76(12.50)	
Heavy	3556(14.31)	3458(14.32)	98(13.75)		211(9.73)	113(8.05)	98(13.75)	
Smoking (n, %)				< 0.001				< 0.001
Never	12840(50.57)	12,780(51.71)	60(8.18)		761(36.71)	701(48.63)	60(8.18)	
Former	8121(31.08)	7727(30.59)	394(49.33)		987(40.40)	593(36.67)	394(49.33)	
Current	4790(18.35)	4491(17.69)	299(42.50)		511(22.89)	212(14.70)	299(42.50)	
Hypertension (n, %)	14,385(49.87)	13,864(49.41)	521(66.99)	< 0.001	1475(59.86)	954(56.88)	521(66.99)	< 0.001
Diabetes (n, %)	6143(18.10)	5906(17.82)	237(28.80)	< 0.001	641(25.25)	404(23.77)	237(28.80)	0.06
CVD (n, %)	4084(12.79)	3774(12.06)	310(39.84)	< 0.001	662(25.35)	352(19.29)	310(39.84)	< 0.001
eGFR, mL/min/1.73m^2	84.98±0.23	85.16±0.24	78.05±0.86	< 0.001	79.20±0.54	79.69±0.65	78.05±0.86	0.117
HDL, mmol/L	1.40±0.01	1.40±0.01	1.39±0.03	0.844	1.39±0.02	1.38±0.02	1.39±0.03	0.707
Platelet, 1000 cells/μL	250.35±0.80	250.19±0.82	256.06±3.37	0.091	244.36±1.96	239.47±2.26	256.06±3.37	< 0.001
PHR	195.27±0.93	194.98±0.96	206.07±4.86	0.029	194.62±2.38	189.83±2.90	206.07±4.86	0.006

Abbreviations: BMI, body mass index; CI, confidence interval; COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease; eGFR, estimated glomerular filtration rate; HDL, high-density lipoprotein cholesterol; PHR, platelet/HDL ratio.

Associations Between PHR and COPD Prevalence

Weighted logistic regression (Table 2) identified a significant association between PHR and the prevalence of COPD, even in the fully adjusted model 2 (OR = 1.002, 95% CI 1.001–1.003). Compared with the reference Q1 group, the ORs, and 95% CIs for the Q2, Q3, and Q4 PHR quartile were 1.162 (0.874–1.546), 1.225 (0.924–1.625), and 1.510 (1.102-–2.069), respectively (P for trend = 0.012). Notably, a significant association between PHR and COPD was still observed in the logistic regression analysis after matching on propensity scores, as shown in Table 3.

Restricted cubic spline analysis (Figure 2) was performed to evaluate the dose–response relationship between PHR and COPD prevalence. The results showed that the PHR was positively associated with COPD both before (P for nonlinearity = 0.080) and after (P for nonlinearity = 0.135) PSM.

Subgroup Analysis

Figure 3 shows the results of subgroup analyses stratified by age, sex, race, hypertension, and diabetes status before and after PSM. The associations between PHR and COPD did not differ among participants of different age, sex, race, and diabetes status. Notably, the significant association between PHR and COPD prevalence was observed only in participants without hypertension both before and after PSM.

We then compared data from participants with and without hypertension. The results indicated that compared with those without hypertension, participants with hypertension had significantly lower HDL (1.43 ± 0.01 mmol/L vs 1.37 ±

Table 2 Associations Between Platelet/High-Density Lipoprotein Cholesterol Ratio (PHR) and Risk of Chronic Obstructive Pulmonary Disease Before Propensity Score Matching

	Crude Model		Model 1		Model 2	
	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
PHR (continuous)	1.003 (1.002–1.004)	<0.001	1.002 (1.001–1.003)	0.004	1.002 (1.001–1.003)	0.004
PHR quartile						
Q1	Reference	/	Reference	/	Reference	/
Q2	1.249 (0.937–1.664)	0.132	1.149 (0.862–1.531)	0.346	1.162 (0.874–1.546)	0.303
Q3	1.409 (1.088–1.824)	0.010	1.206 (0.922–1.577)	0.174	1.225 (0.924–1.625)	0.161
Q4	1.898 (1.408–2.557)	<0.001	1.487 (1.094–2.022)	0.013	1.510 (1.102–2.069)	0.011
P for trend	<0.001		0.011		0.012	

Notes: The crude model was unadjusted. Model 1 was adjusted for participants' age, sex, race, marital status, education level and poverty–income ratio. The model 2 was further adjusted for body mass index, drinking, smoking, and comorbidities of hypertension, diabetes, and cardiovascular diseases.

Abbreviations: CI, confidence interval; OR, odds ratio; PHR, platelet/high-density lipoprotein cholesterol ratio; Q1-Q4 represents the lowest to the highest quartiles of PHR.

0.01 mmol/L, P < 0.001), higher COPD prevalence (3.53% vs 1.73%, P < 0.001), and statistically insignificant platelet count (251.29 ± 1.00 per 1000 cells/μL vs 249.40 ± 0.99 per 1000 cells/μL, P = 0.109).

ROC Curve Analysis

We compared the capabilities of platelets, HDL, and PHR for discriminating COPD from non-COPD both before and after PSM. As shown in Figure 4 and Table 4, platelets and HDL could not distinguish COPD from non-COPD participants both before and after PSM. In comparison, the discriminative ability of PHR, as indicated by the area under the curve, was significantly higher than that of the platelets and HDL both before and after PSM.

Table 3 Associations Between Platelet/High-Density Lipoprotein Cholesterol Ratio (PHR) and Risk of Chronic Obstructive Pulmonary Disease After Propensity Score Matching

	Crude Model		Model 1		Model 2	
	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
PHR (continuous)	1.003 (1.001–1.004)	0.001	1.002 (1.001–1.004)	0.002	1.002 (1.001–1.004)	0.004
PHR quartile						
Q1	Reference	/	Reference	/	Reference	/
Q2	1.231 (0.903–1.680)	0.187	1.208 (0.887–1.644)	0.228	1.162 (0.855–1.580)	0.336
Q3	1.287 (0.928–1.785)	0.129	1.238 (0.895–1.714)	0.196	1.187 (0.856–1.647)	0.301
Q4	1.825 (1.277–2.608)	0.001	1.753 (1.233–2.493)	0.002	1.625 (1.148–2.300)	0.007
P for trend	0.002		0.003		0.009	

Notes: The crude model was unadjusted. Model 1 was adjusted for participants' age, sex, race, marital status, education level, and poverty–income ratio. The model 2 was further adjusted for body mass index, drinking, smoking, and comorbidities of hypertension, diabetes, and cardiovascular diseases.

Abbreviations: CI, confidence interval; OR, odds ratio; PHR, platelet/high-density lipoprotein cholesterol ratio; Q1-Q4, represents the lowest to the highest quartiles of PHR.

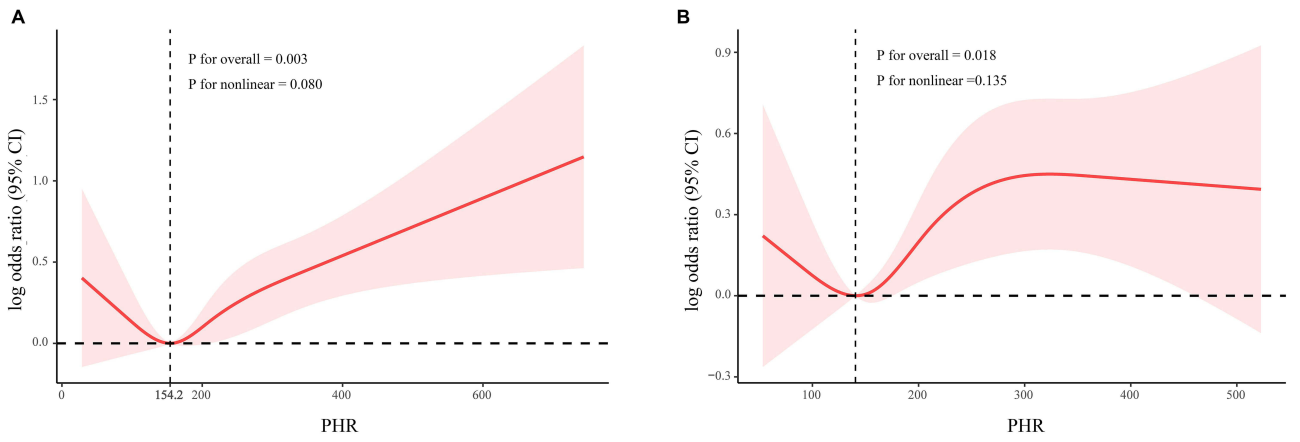

Figure 2 Restricted cubic spline analysis of the multivariable-adjusted association between PHR values and the prevalence of chronic obstructive pulmonary disease before (**A**) and after (**B**) propensity score matching.

Discussion

The present cross-sectional study examined the association between PHR and prevalence of COPD using a nationally representative, population-based cohort from the NHANES. We found that a higher PHR was linearly associated with increased prevalence of COPD, which was further supported by the restricted cubic spline analysis. In addition, hypertension status significantly modified this relationship, as significant association between PHR and COPD prevalence was observed only in participants without hypertension. The ROC results indicated superior performance of PHR over platelet counts and HDL for distinguishing COPD from non-COPD. Subsequent PSM further confirmed the robustness and validity of the study results.

In the current study, COPD patients were associated with certain socio-demographic characteristics even after PSM, such as lower educational level, lower poverty–income ratio, and higher prevalence of being single. This observation is consistent with the fact that smoking, which is an important risk factor for the development of COPD, is more prevalent in socioeconomically disadvantaged individuals. This finding also echoed a previous study showing that higher educational level, higher annual household income, and access to medical services were associated with a lower risk of COPD.[16]

Comparison of the COPD and non-COPD groups showed no statistical difference in HDL levels, while significantly higher platelet levels were observed in the COPD group. Burkart et al demonstrated that a higher HDL is associated with worse lung function indicated by lower forced expiratory volume at 1 second/forced vital capacity ratio, and greater percent emphysema, highlighting that an elevated HDL may instead increase the risk of COPD.[17] A multicenter study indicated that a lower serum HDL level may reduce forced expiratory volume at 1 second in patients with COPD.[18] Congruently, Markelić et al showed an elevated level of HDL in COPD patients, especially in those with advanced stages.[19] However, the meta-analysis of 615 COPD and 471 controls showed no significant differences in HDL levels between COPD and controls.[7] The work by Wen et al indicated a non-linear association between HDL and lung function in COPD, with HDL elevation before 66 mg/dl was associated with emphysema and impaired lung function.[20] HDL has been found to be implicated in the inflammatory activation of alveolar macrophages and the induction of neutrophil proliferation,[21] both of which significantly contribute to airway inflammation and thus increased risk for the development of chronic lung conditions like COPD. Another theory holds that HDL could modulate type II alveolar cells and thus alters the surface characteristics of pulmonary surfactant.[22] In fact, confounding factors of steroid use and the pro-inflammatory nature of HDL in chronic conditions have also been employed to explain the relationship between HDL and COPD.[23]

Available reports have consistently shown an elevated platelet count in patients with COPD. For example, Zinellu's group performed a meta-analysis and found that COPD patients had significantly higher platelet counts than non-COPD patients, which is consistent with our findings.[5] It has also been observed that platelet count is positively associated with

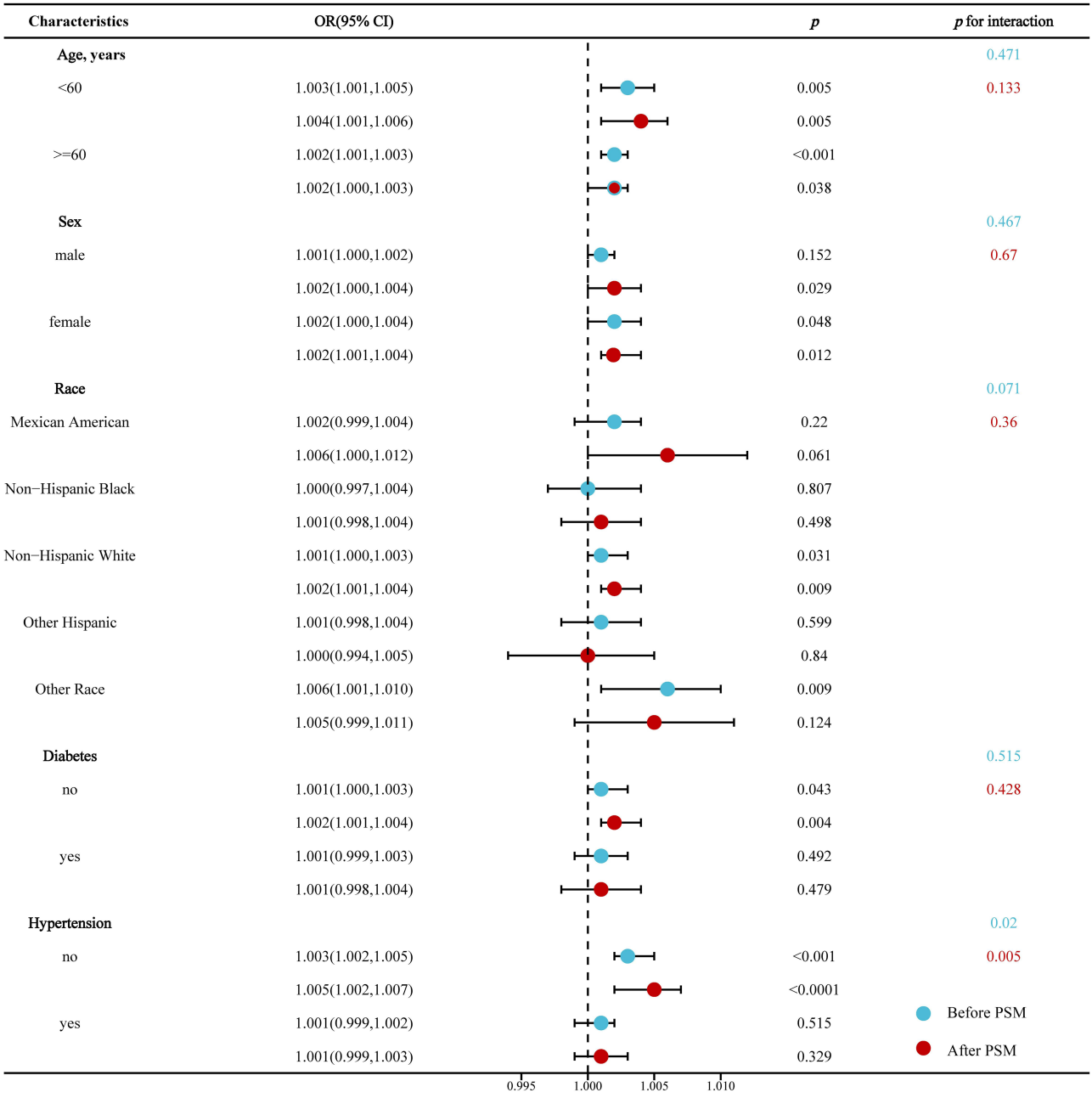

Figure 3 Forest plot showing the results of subgroup analysis for the association between PHR and chronic obstructive pulmonary disease before and after propensity score matching.

COPD severity.[24] Platelets were implicated in the development and exacerbation of COPD through multiple mechanisms, including destruction of lung elasticity by secreting platelet factor 4, and induction of a pro-thrombotic state and pulmonary vascular remodeling.[25] Consequently, a significantly elevated platelet count has also been associated with an increased risk of all-cause mortality, and antiplatelet therapy with aspirin may improve COPD symptoms and quality of life.[26]

Logistic regression analysis showed that PHR, both as a continuous and categorical variable, was significantly associated with COPD prevalence even after adjustment for potential confounders and after PSM. In addition, the ROC curve analysis indicated superior performance of PHR over platelet counts and HDL for distinguishing COPD from non-COPD. The PHR, which combines the predictive value of circulating platelet count and HDL into a single ratio, has

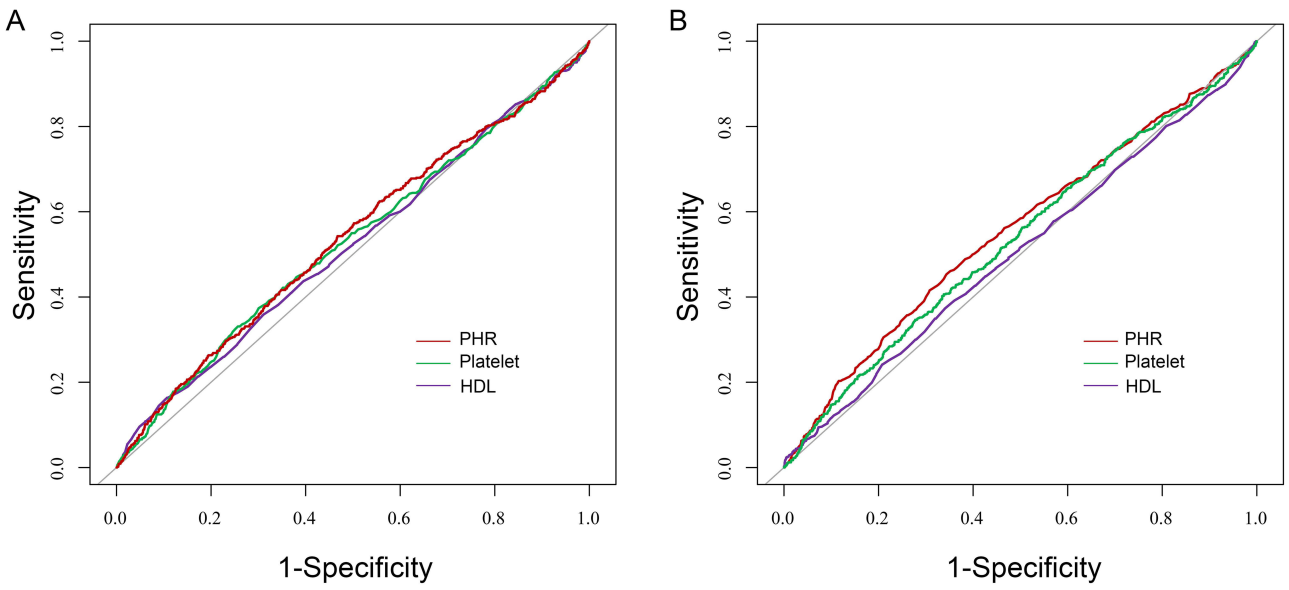

Figure 4 Receiver-operating characteristic curves for the discrimination of COPD from non-COPD by platelet count, HDL, and PHR before (**A**) and after (**B**) propensity score matching.
Abbreviations: COPD, chronic obstructive pulmonary disease; HDL, high-density lipoprotein cholesterol; PHR, platelet count to HDL ratio.

previously been reported to be associated with cardiovascular mortality in stroke and all-cause mortality in patients with coronary artery disease in longitudinal studies.[11,27] More importantly, the PHR has demonstrated superior utility in predicting cardiovascular mortality risk than platelet and HDL alone, which is compatible with our results.[11] In addition, the elevated PHR has also been cross-sectionally associated with an increased prevalence of nephrolithiasis, non-alcoholic liver disease, and acute mania.[9,10,28] HDL has been shown to counteract the pro-coagulation effect of platelets by stimulating clot fibrinolysis.[29] Thus, an elevated PHR may indicate pro-coagulation status, which has been implicated in the development of airflow obstruction and emphysema. Therefore, the PHR may serve as a convenient, readily available and informative biomarker for COPD.

An interesting finding of this study is that the association between PHR and COPD was only present in those without hypertension. Comparison of participants with and without hypertension showed similar platelet counts, and the higher PHR level in participants with hypertension was primarily contributed by the significantly lower HDL levels in this group. Our main findings suggest that platelet count, rather than HDL, may be the main contributor to the association

Table 4 Receiver-Operating Characteristic Curve Results for the Discrimination of COPD from Non-COPD

Variables	Optimal Cut-off	AUC (95% CI)	Sensitivity (%)	Specificity (%)	Comparative P value
Before propensity score matching					
Platelet count	272.5 (1000 cells/μL)	0.529 (0.483–0.555)	33.10	74.31	0.045
HDL	0.935 (mmol/L)	0.520 (0.495–0.546)	16.37	89.30	0.038
PHR	177.29	0.537 (0.512–0.563)	54.27	53.27	Reference
After propensity score matching					
Platelet count	255.5 (1000 cells/μL)	0.536 (0.490–0.561)	34.66	72.24	0.048
HDL	1.655 (mmol/L)	0.505 (0.479–0.530)	24.17	79.22	0.006
PHR	218.27	0.557 (0.531–0.582)	55.29	65.67	Reference

Abbreviations: AUC, area under the curve; CI, confidence interval; HDL, high-density lipoprotein cholesterol; PHR, platelet to HDL ratio.

between PHR and COPD prevalence. Notably, these results indicate that PHR may be discordantly associated with COPD. Consequently, clinical attention should be tailored to specific subgroups to provide more guidance to participants without hypertension. It is likely that there are additional operating mechanisms underlying this difference in COPD patients with and without hypertension that are worthy of further investigation in the future.

Strengths of this study include its national representativeness and large sample size, coupled with PSM controlling for age, sex, and race. Previous studies have shown that people of different sexes and races not only have a completely different risk of COPD but also a disproportionate mortality rate, especially in African Americans.[30,31] However, this study also suffers from several limitations that should be acknowledged. First, the observational cross-sectional design renders causal interpretation between PHR and COPD difficult, for which longitudinal cohort studies are needed. Second, the diagnosis of COPD in the current study was self-reported, which may introduce recall bias and defy classification of COPD severity. Documentation of forced expiratory volume in 1 second/forced vital capacity < 70% after bronchodilation would probably be more objective. Finally, it appears that we failed to account for COPD severity and acute exacerbation status in this study, as both have been reported to affect platelet count and HDL levels.

Conclusion

In conclusion, this cross-sectional study revealed a higher PHR is associated with increased prevalence of COPD in participants without hypertension. Thus, PHR serves as a potential biomarker for COPD that deserves additional investigation. Longitudinal cohort studies are needed to establish this relationship.

Data Sharing Statement

The data that support the findings of this study are available on request from the corresponding author upon reasonable request.

Ethics Statement

This study uses data from a publicly available database, in which all study participants gave informed consent in accordance with the Institutional Review Board and study ethic guidelines at the Centers for Disease Control and Prevention. Ethical approval for the current study was exempted from the Ethics Committee of Shanghai Tenth People's Hospital.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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