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ORIGINAL RESEARCH

Association of Relative Fat Mass and Conicity Index with the Risk of Hyperuricemia in Obese Women with PCOS: A Cross-Sectional Study

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Objective: Hyperuricemia (HUA) is a prevalent metabolic disorder closely linked to both obesity and polycystic ovary syndrome (PCOS). Traditional obesity indices, such as body mass index (BMI), may not fully capture the metabolic risks associated with fat distribution. This study aimed to investigate the association between relative fat mass (RFM), the conicity index (C-index), and the risk of HUA in obese women with PCOS to improve clinical metabolic risk stratification.

Methods: This cross-sectional study included 487 obese women aged 18–45 years with PCOS diagnosed by the revised Rotterdam criteria. Anthropometric indices (RFM, C-index) were calculated and categorized into quartiles. Logistic regression, adjusted for age, diabetes, and hypertension, assessed associations with HUA. Restricted cubic spline (RCS) analyses evaluated nonlinear relationships, and subgroup analyses tested robustness across age and metabolic subgroups.

Results: HUA was significantly more prevalent among obese women with PCOS (71.6%) compared to the rate in the non-PCOS counterparts (50.4%; $p < 0.001$). Elevated RFM was strongly associated with HUA, with adjusted ORs of 4.94 (95% CI: 1.52–16.11) and 3.41 (95% CI: 1.15–10.12) for the third and fourth quartiles, compared to the first ($p < 0.05$). Conversely, the C-index demonstrated a weaker association with the manifestation of HUA, with limited increases in risk across quartiles. The RCS analyses revealed a linear relationship between RFM and HUA after adjusting for potential confounders, while the C-index showed no significant dose-response trend. Finally, the subgroup analyses confirmed the stability of these associations across the age, hypertension, and hyperlipidemia subgroups.

Conclusion: RFM is significantly associated with HUA in obese women with PCOS and outperforms the C-index as a predictor of metabolic dysfunction. These findings underscore the potential clinical utility of RFM as a practical tool for early identification and metabolic risk stratification in this high-risk population.

Keywords: obesity, polycystic ovary syndrome, hyperuricemia, relative fat mass, conicity index, metabolic dysfunction

Introduction

Polycystic ovary syndrome (PCOS) is a complex endocrine disorder that affects 6–20% of women of reproductive age and is characterized by hyperandrogenism, ovulatory dysfunction, and polycystic ovarian morphology.[1] Beyond its associations with various reproductive issues, PCOS is also closely linked to certain metabolic abnormalities, including insulin resistance, obesity, and dyslipidemia, all of which can significantly increase the risk of cardiovascular disease and type 2 diabetes.[2,3]

Obesity, particularly abdominal obesity, is highly prevalent among women with PCOS, further compounding the already elevated metabolic risks. However, whether PCOS with comorbid obesity exacerbates specific metabolic disorders, such as hyperuricemia (HUA), remains unknown. HUA, which is characterized by elevated serum levels of uric acid, not only contributes to systemic inflammation but also exacerbates ovulatory dysfunction and disrupts both

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glucose and lipid metabolism.[4,5] Therefore, a better understanding of the interplay between obesity, PCOS, and HUA is crucial, given the potential for compounded risks of adverse effects that can impact an individual's reproductive and metabolic health.

Traditional measures of obesity, such as body mass index (BMI), inadequately capture fat distribution, which is a key determinant of metabolic risk. In recent years, emerging anthropometric indices have been developed to provide more accurate estimates of adiposity patterns. Relative fat mass (RFM), calculated using height and waist circumference, has been validated against dual-energy X-ray absorptiometry (DXA) and shown to more accurately estimate whole-body fat mass than BMI.[6] The conicity index (C-index), derived from waist circumference, weight, and height, reflects abdominal conicity and central fat accumulation, and has been associated with visceral adipose tissue distribution and cardiometabolic risk in multiple populations.[7,8] These features suggest that RFM and the C-index may offer more nuanced assessment of body composition and may help identify individuals at increased risk of metabolic abnormalities beyond conventional obesity measures. Although prior research has examined anthropometric measures and body-fat distribution in relation to metabolic abnormalities in women with PCOS—including studies linking neck circumference to metabolic syndrome and imaging-derived visceral adipose tissue mass to hyperuricemia—evidence evaluating newer,[5,9] simple adiposity indices such as the conicity index (C-index) and relative fat mass (RFM) remains limited. In particular, no study has specifically investigated the association of C-index or RFM with hyperuricemia in women with PCOS, and none have directly compared the predictive performance of these two indices in this high-risk population.

The aim of this study was to address these knowledge gaps by investigating the respective associations between the C-index and RFM and the occurrence of HUA among obese women with PCOS. This study also evaluated potential nonlinear relationships and examined the consistency of these associations across clinically relevant subgroups.

Materials and Methods

Participants and Design

This retrospective study analyzed data sourced from the Obstetrics and Gynecology Department of Taixing People's Hospital. A total of 525 obese women were initially screened for eligibility. After excluding 38 individuals for the following reasons—diagnosed diabetes or current use of hypoglycemic agents (n = 4), history of more than one bariatric surgery (n = 2), adolescent-onset PCOS (n = 4), and incomplete clinical data (n = 28)—a total of 487 participants were finally included in the analysis (Figure 1). Based on the World Health Organization (WHO) standards, female participants were eligible if they met the following criteria:[10] 1) a BMI ≥ 28 kg/m^2; and (2) age between 18 and 45 years. The exclusion criteria were: 1) a history of bariatric surgery or the use of anti-obesity medications prior to the initial visit of the study period; 2) the use of exogenous insulin or medications known to affect glucose metabolism, uric acid levels, or sex hormones prior to the study; 3) a diagnosis of type 1 diabetes, secondary diabetes, hereditary disorders, or serious illnesses (such as malignancies, heart failure, or hepatic failure); 4) being pregnant or actively breastfeeding at the time of the study; and 5) missing important clinical data that was relevant to the study.

All eligible cases during the study period were included to maximize statistical power and reduce selection bias. The final sample of 487 participants provided an adequate number of hyperuricemia events to satisfy events-per-variable (EPV) criteria for logistic regression analyses.

All participants, or their guardians when applicable, provided written informed consent before taking part in the study. Ethical approval was granted by the Institutional Ethics Committee of Taixing People's Hospital (Approval No. LS2025015), and the study complied with the Declaration of Helsinki.

Definition of PCOS

The diagnosis of PCOS was determined according to the 2003 revised Rotterdam criteria.[1] Participants were required to fulfill at least two of the following three diagnostic features: 1) infrequent or absent menstrual periods; 2) clinical (eg, hirsutism and acne) and/or biochemical signs of hyperandrogenism; and 3) polycystic ovarian morphology on ultrasound, defined as twelve or more follicles measuring 2–9 mm per ovary or an ovarian volume exceeding 10 mL. Alternative

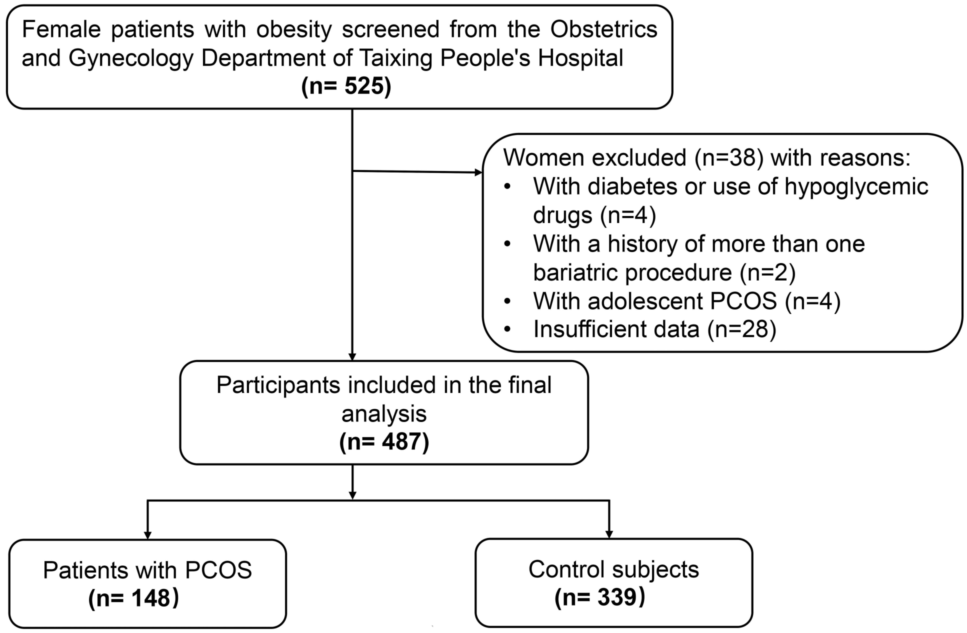

Figure 1 Participation flowchart.

causes, including congenital adrenal hyperplasia, androgen-producing tumors, and Cushing's syndrome, were systematically ruled out.

Anthropometric Assessment and Laboratory Measurements

This study collected baseline data, including information on the patients' age, height, weight, and BMI. Blood pressure was recorded using an automated device with participants seated at rest, and in the absence of antihypertensive therapy, hypertension was defined by a systolic blood pressure ≥140 mmHg and/or a diastolic blood pressure ≥90 mmHg.

Venous blood samples were collected after an overnight fast of at least 8 hours to determine biochemical and hormonal parameters. Diabetes was diagnosed according to the WHO 1999 criteria,[11] which included a fasting plasma glucose concentration ≥ 7.0 mmol/L, a 2-hour post–oral glucose tolerance test (OGTT) value ≥ 11.1 mmol/L, or the use of antidiabetic medication.

Dyslipidemia was diagnosed when any of the following lipid abnormalities were present: total cholesterol ≥ 5.2 mmol/L, triglycerides ≥ 1.7 mmol/L, high-density lipoprotein cholesterol (HDL-c) < 1.0 mmol/L in women, or low-density lipoprotein cholesterol (LDL-c) ≥ 3.35 mmol/L. Any of these abnormalities or a history of treatment for dyslipidemia was indicative of the condition in the study population.[12]

Hyperuricemia was identified when serum uric acid concentration exceeded 360 µmol/L in women.[13]

Assessment of the C-Index and RFM

Height was measured using a calibrated stadiometer, with patients standing upright and barefoot, with their backs, heels, and shoulders aligned.

The measurement of waist circumference (WC) was taken halfway between the lowest rib and the iliac crest, with participants standing with their feet together and arms relaxed. A non-elastic measuring tape was wrapped snugly and horizontally around the waist, without compressing the skin, and measurements were recorded at the end of a normal expiration. All measurements were conducted by trained personnel to ensure accuracy.

The C-index was subsequently calculated using the following formula, as previously described:[8]

$$\text{C-index}=0.109^{-1}\text{WC(m)}[\text{Weight(kg)}/\text{Height(m)}]^{-1/2}$$

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RFM was calculated using the following formula, as previously described:[6]

$$RFM_{women}=76-20\times[Height(m)/WC(m)]$$

Statistical Analyses

Data analysis employed SPSS 23.0 (IBM, Chicago, IL, USA), GraphPad Prism 9.0 (San Diego, CA, USA), and R 4.2.2. Quartiles (Q1 to Q4) were generated to categorize the C-index and RFM values. To assess normality, the Kolmogorov–Smirnov test was employed. Variables conforming to a normal distribution are summarized as mean ± SD, while skewed variables are expressed as median with IQR. For intergroup comparisons of variables with a normal distribution, independent sample *t*-tests were employed and non-normally distributed variables were analyzed using Mann–Whitney *U*-tests. Differences across multiple groups were assessed by one-way ANOVA. Point-biserial correlation analysis was applied to evaluate the association between HUA status (dichotomous) and continuous variables such as the C-index and RFM. To further explore the link between HUA and the C-index or RFM, multivariable logistic regression was performed, and odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. Model 1 was unadjusted, while Model 2 accounted for age, diabetes, and hypertension. In the context of obese women with PCOS, restricted cubic splines (RCS) and smooth logistic regression were utilized for curve fitting. Additionally, stratified analyses were performed based on age (≤ 31 years or > 31 years) and the presence or absence of diabetes, hypertension, and hyperlipidemia. Two-sided tests were applied throughout, and significance was defined as $p < 0.05$. This study was designed and reported following the STROBE guidelines for cross-sectional research.

Results

Prevalence of Comorbidities in Obese Patients with PCOS

As shown in Figure 2, there was no statistically significant difference in the incidence of diabetes mellitus between obese women with and without PCOS, with rates of 26.2% and 24.6%, respectively ($p = 0.734$). The prevalence of hypertension was 47.6% in the PCOS group and 39.2% in the non-PCOS cohort, with no statistically significant difference between groups ($p = 0.092$). The prevalence of hyperlipidemia was also similar in both groups, affecting 49.4% of patients with PCOS and 45% of those without PCOS ($p = 0.388$).

In contrast, a significant intergroup difference was observed for the prevalence of HUA, which was considerably higher in the PCOS group at 71.6% compared with a rate of 50.4% in the non-PCOS group ($p < 0.001$). Collectively, these findings suggest that while the rates of diabetes, hypertension, and hyperlipidemia were similar between those with and without PCOS, HUA was notably more prevalent among the former group.

Baseline Characteristics of Participants with and without PCOS

Four groups were established based on whether HUA was or was not observed among individuals with and without PCOS. As detailed in Table 1, significant differences were identified for the fasting insulin (FINS) and hemoglobin A1c (HbA1c) levels, the C-index, and RFM between the subgroups of patients with PCOS, whereas no notable differences identified among the patients without PCOS.

For the non-PCOS individuals, the mean C-index was 1.31 ± 0.09 in the HUA group and 1.31 ± 0.10 in the non-HUA group ($p = 0.698$), indicating a lack of significant variation. In contrast, for the patients with PCOS, a significant difference in C-index values was observed, with the HUA group exhibiting a C-index of 1.31 (1.26, 1.34) compared to a value of 1.26 (1.22, 1.34) in the non-HUA group ($p = 0.049$).

The non-PCOS participants exhibited RFM values of 45.29 ± 3.39 in the HUA group and 44.59 ± 4.09 in the non-HUA group, with no significant difference between the two ($p = 0.09$). However, within the PCOS cohort, RFM measurements were significantly higher in the HUA group at 44.86 (42.75, 47.52) compared to values in the non-HUA group of 42.74 (41.11, 45.91) ($p = 0.006$).

These findings suggested that elevated C-index and RFM values may be associated with the higher prevalence of HUA observed in obese women with PCOS.

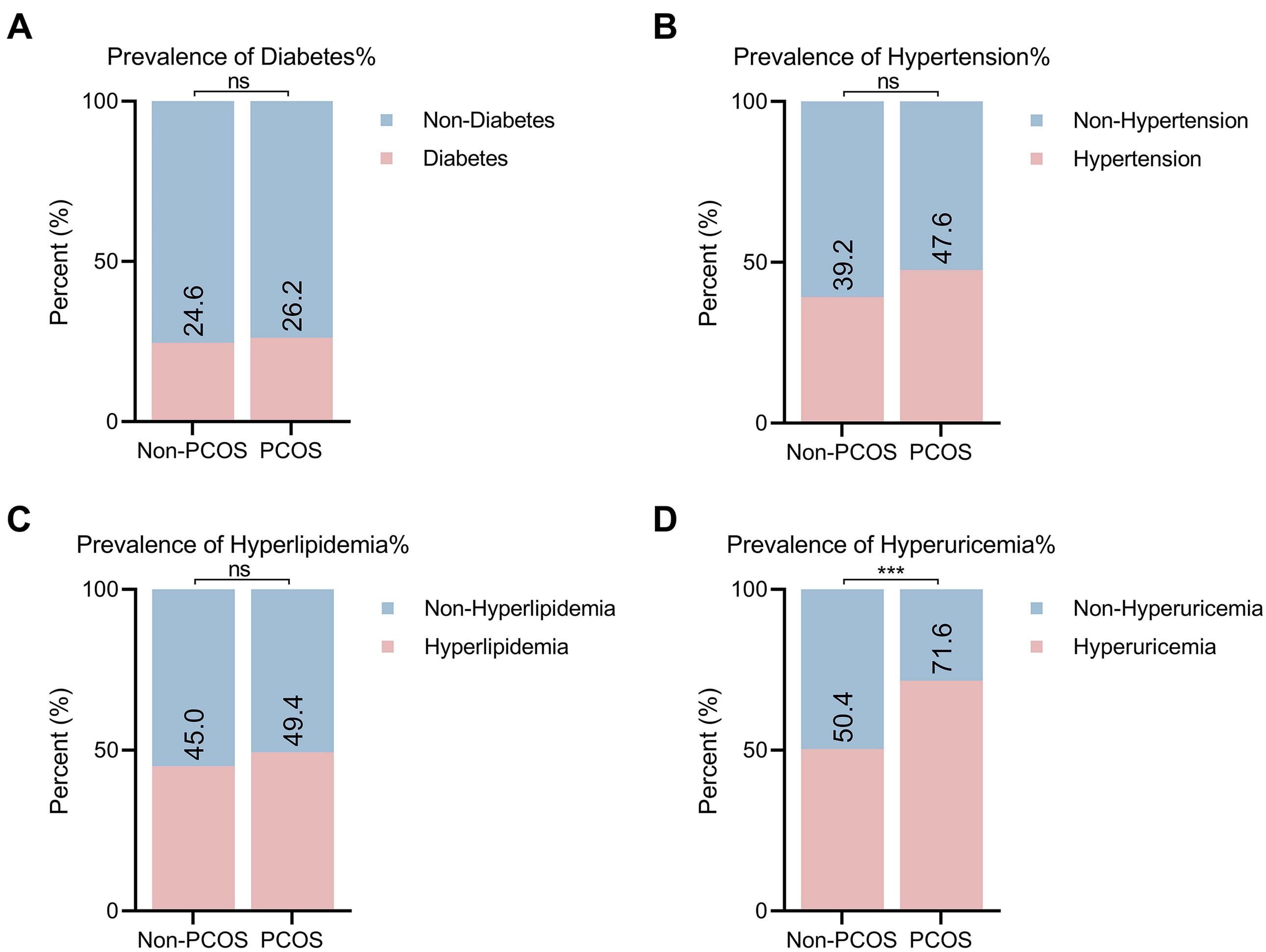

Figure 2 Prevalence of comorbidities in obese patients with and without PCOS. Comparison of the prevalence of (**A**) diabetes, (**B**) hypertension, (**C**) hyperlipidemia, and (**D**) hyperuricemia between obese patients diagnosed with PCOS or not. Data are expressed as percentages. Statistical significance was assessed using χ^2 tests. ***$p < 0.001$.
Abbreviations: PCOS, polycystic ovary syndrome; ns, no significance.

Relationships Between the C-Index or RFM and HUA

To further assess the relationship between the C-index or RFM and the presence of hyperuricemia (HUA), a bivariate correlation analysis was conducted. As illustrated in Figure 3, individuals with HUA exhibited significantly higher levels of both the C-index and RFM compared to those without HUA. Point-biserial correlation analysis further confirmed

Table 1 Comparison of Baseline Characteristics Between Participants with and without PCOS

	Non-PCOS (n=339)			PCOS (n=148)		
	NUA (n=168)	**HUA (n=171)**	***p* value**	**NUA (n=42)**	**HUA (n=106)**	***p* value**
Age, years	29.00 (22.00, 35.00)	31.00 (24.00, 40.00)	0.065	29.00 (20.50, 44.50)	31.00 (26.00, 41.00)	0.588
BMI, kg/m^2	33.00 (28.20, 36.38)	34.70 (30.80, 38.83)	<0.001***	31.10 (28.45, 37.10)	35.32 (31.60, 38.81)	0.006**
SBP, mmHg	129.00 (117.75, 139.25)	130.00 (121.00, 145.00)	0.134	131.00 (120.00, 141.00)	131.00 (121.00, 144.50)	0.607
DBP, mmHg	82.00 (73.75, 90.00)	82.00 (75.00, 91.00)	0.609	85.00 (78.00, 90.00)	86.00 (76.00, 92.00)	0.700
FINS, mmol/L	17.88 (12.99, 27.10)	25.52 (18.75, 37.04)	0.686	22.07 (15.95, 31.98)	30.53 (23.08, 41.66)	<0.001***
HbA1c, %	5.70 (5.40, 6.85)	5.80 (5.40, 6.50)	0.818	6.30 (5.68, 8.65)	5.70 (5.50, 6.30)	0.042*

(*Continued*)

Table 1 (Continued).

	Non-PCOS (n=339)			**PCOS (n=148)**		
	NUA (n=168)	**HUA (n=171)**	***p* value**	**NUA (n=42)**	**HUA (n=106)**	***p* value**
HOMA-IR	4.50 (3.11, 6.83)	6.42 (4.31, 9.08)	<0.001***	5.61 (3.64, 8.66)	7.36 (5.14, 11.12)	0.009**
TC, mmol/L	4.59 (4.00, 5.34)	4.72 (4.19, 5.58)	0.117	4.67 (4.11, 4.93)	4.69 (4.20, 5.38)	0.180
TG, mmol/L	1.31 (0.97, 1.97)	1.57 (1.15, 2.21)	0.007**	1.39 (0.92, 1.89)	1.51 (1.24, 2.12)	0.039*
HDL, mmol/L	1.15 (1.00, 1.31)	1.06 (0.92, 1.23)	0.004**	1.12 (0.97, 1.33)	1.04 (0.90, 1.25)	0.094
LDL, mmol/L	2.88±0.85	2.99±0.90	0.268	2.73±0.65	2.99±0.72	0.051
ALT, U/L	21.85 (14.53, 36.98)	33.20 (21.38, 69.58)	<0.001***	26.05 (17.30, 43.23)	56.80 (30.95, 84.25)	<0.001***
AST, U/L	18.65 (15.33, 27.15)	25.30 (18.13, 42.08)	<0.001***	22.20 (16.00, 29.23)	31.85 (21.55, 47.23)	0.001**
Cr, umol/L	54.10 (49.55, 58.20)	58.00 (51.10, 64.00)	0.026*	59.10 (55.30, 66.40)	61.10 (51.60, 71.30)	0.654
BUN, mmol/L	4.63±1.34	4.46±0.91	0.359	4.50 (3.85, 4.88)	4.70 (4.11, 5.67)	0.463
UA, umol/L	305.50 (274.38, 336.80)	415.5 (387.6, 457.20)	<0.001***	322.20 (291.48, 349.63)	440.05 (401.70, 488.93)	<0.001***
LH, IU/L	6.70 (4.22, 14.47)	6.47 (4.16, 9.89)	0.165	8.62 (3.71, 13.48)	7.60 (5.34, 11.72)	0.852
FSH, IU/L	6.13 (3.60, 10.66)	5.32 (3.68, 6.57)	0.042*	5.66 (4.15, 6.57)	5.04 (4.13, 6.19)	0.210
Testosterone, ng/mL	0.27 (0.16, 0.38)	0.29 (0.19, 0.42)	0.017*	0.75 (0.64, 0.92)	0.75 (0.64, 0.92)	0.768
C-index	1.31±0.10	1.31±0.09	0.698	1.26 (1.22, 1.34)	1.31 (1.26, 1.34)	0.049*
RFM	44.59±4.09	45.29±3.39	0.090	42.74 (41.11 45.91)	44.86 (42.75, 47.52)	0.006**

Notes: Data are expressed as the mean ± SD or median (upper and lower quartiles). *p* value was a significant difference between NUA and HUA. *$p < 0.05$, **$p < 0.01$ and ***$p < 0.001$.

Abbreviations: PCOS, polycystic ovary syndrome; NUA, Non-hyperuricaemia; HUA, hyperuricaemia; BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; FINS, fasting serum insulin; HbA1c, glycated hemoglobin; HOMA-IR, homeostatic model assessment insulin resistance; TC, total cholesterol; TG, triglycerides; HDL, high-density lipoprotein cholesterol; LDL, low-density lipoprotein cholesterol; ALT, alanine aminotransferase; AST, aspartate aminotransferase; Cr, creatinine; BUN, Blood urea nitrogen; UA, uric acid; LH, luteinizing hormone; FSH, follicle-stimulating hormone; C-index, conicity-index; RFM, relative fat mass.

a significant positive association between HUA status (as a dichotomous variable) and both the C-index and RFM (both $p < 0.05$), suggesting that higher levels of these indices are moderately associated with the presence of HUA.

To further analyze these relationships, quartiles were generated based on the C-index and RFM values, and logistic regression analyses were performed to assess the likelihood of HUA (Table 2). The ORs for RFM quartiles Q3 and Q4, relative to Q1, were 4.94 (95% CI: 1.52–16.11) and 3.41 (95% CI: 1.15–10.12), respectively; this suggests that the risk of HUA was substantially increased by 394% for RFM Q3 and 241% for RFM Q4. Additionally, after adjusting for age,

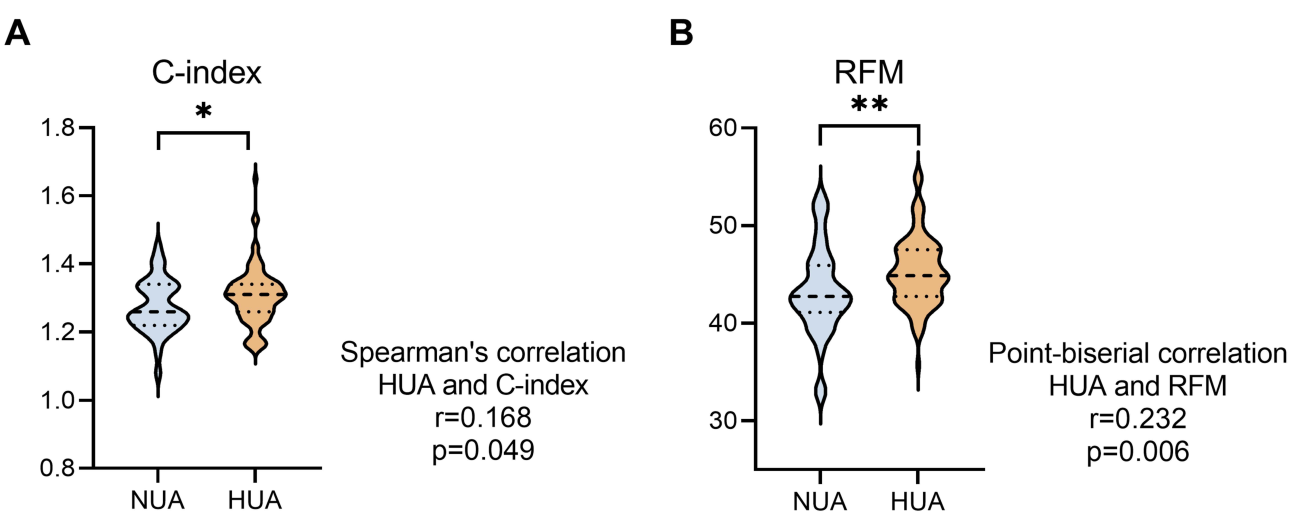

Figure 3 Violin plots comparing the C-index and RFM values between groups. The panels depict the comparisons of the (**A**) C-index and (**B**) RFM values in obese patients with PCOS with or without hyperuricemia. Each plot shows the median, interquartile range, and overall data distribution. Spearman correlation analysis was performed to assess the relationships between both the C-index and RFM with the hyperuricemia status, and correlation coefficients (r) and p-values provided for each analysis. * $p < 0.05$ and ** $p < 0.01$.

Abbreviations: C-index, conicity index; RFM, relative fat mass; PCOS, polycystic ovary syndrome.

Table 2 Association of C-Index and RFM with Hyperuricemia

Variables	Model 1		Model 2	
	OR (95% CI)	*p* value	OR (95% CI)	*p* value
C-index				
1	1.00 (Reference)		1.00 (Reference)	
2	1.68 (0.62 ~ 4.54)	0.307	1.49 (0.47 ~ 4.76)	0.499
3	2.96 (0.95 ~ 9.21)	0.060	2.71 (0.77 ~ 9.57)	0.121
4	2.39 (0.83 ~ 6.88)	0.105	2.78 (0.83 ~ 9.29)	0.097
RFM				
1	1.00 (Reference)		1.00 (Reference)	
2	1.65 (0.61 ~ 4.43)	0.323	1.11 (0.35 ~ 3.54)	0.864
3	4.94 (1.52 ~ 16.11)	0.008**	4.72 (1.33 ~ 16.73)	0.016*
4	3.41 (1.15 ~ 10.12)	0.027*	3.57 (1.05 ~ 12.08)	0.041*

Notes: Logistic regression analyses of the association between hyperuricemia and quartiles of the C-index (upper panel) and RFM (lower panel). Model 1 presents unadjusted *p* value, odds ratios (ORs), and 95% confidence intervals (CIs). Model 2 presents *p* value, odds ratios (ORs), and 95% confidence intervals (CIs) adjusted for age, diabetes, and hypertension. *$p < 0.05$ and **$p < 0.01$.

Abbreviations: C-index, conicity index; RFM, relative fat mass; OR, odds ratio; CI, confidence interval.

diabetes, and hypertension, the risk associated with RFM values in Q3 and Q4 remained statistically significant when compared to Q1 values. Conversely, there was no corresponding increase in risk across the C-index quartiles.

These results suggest that elevated RFM may be linked to HUA, which may contribute to the underlying mechanisms driving HUA in patients with PCOS and comorbid obesity.

Detection of Nonlinear Relationships

After multivariable adjustment, restricted cubic spline (RCS) analyses were performed to examine the dose–response relationships between the C-index, RFM, and the risk of hyperuricemia (HUA), as depicted in Figure 4. The analyses

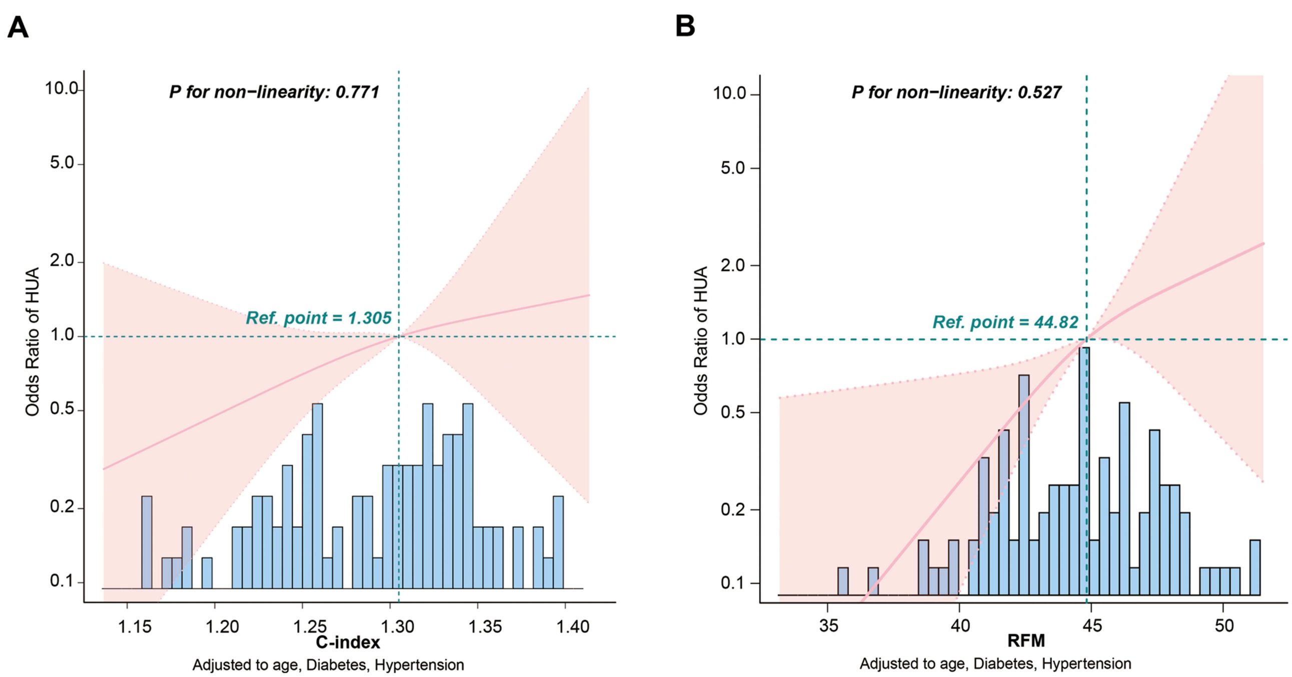

Figure 4 Restricted cubic spline plots for the risk of hyperuricemia. (**A**) Restricted cubic spline curve for the conicity index (C-index). (**B**) Restricted cubic spline curve for relative fat mass (RFM). All models were adjusted for age, diabetes, and hypertension.

Abbreviations: C-index, conicity index; RFM, relative fat mass; PCOS, polycystic ovary syndrome.

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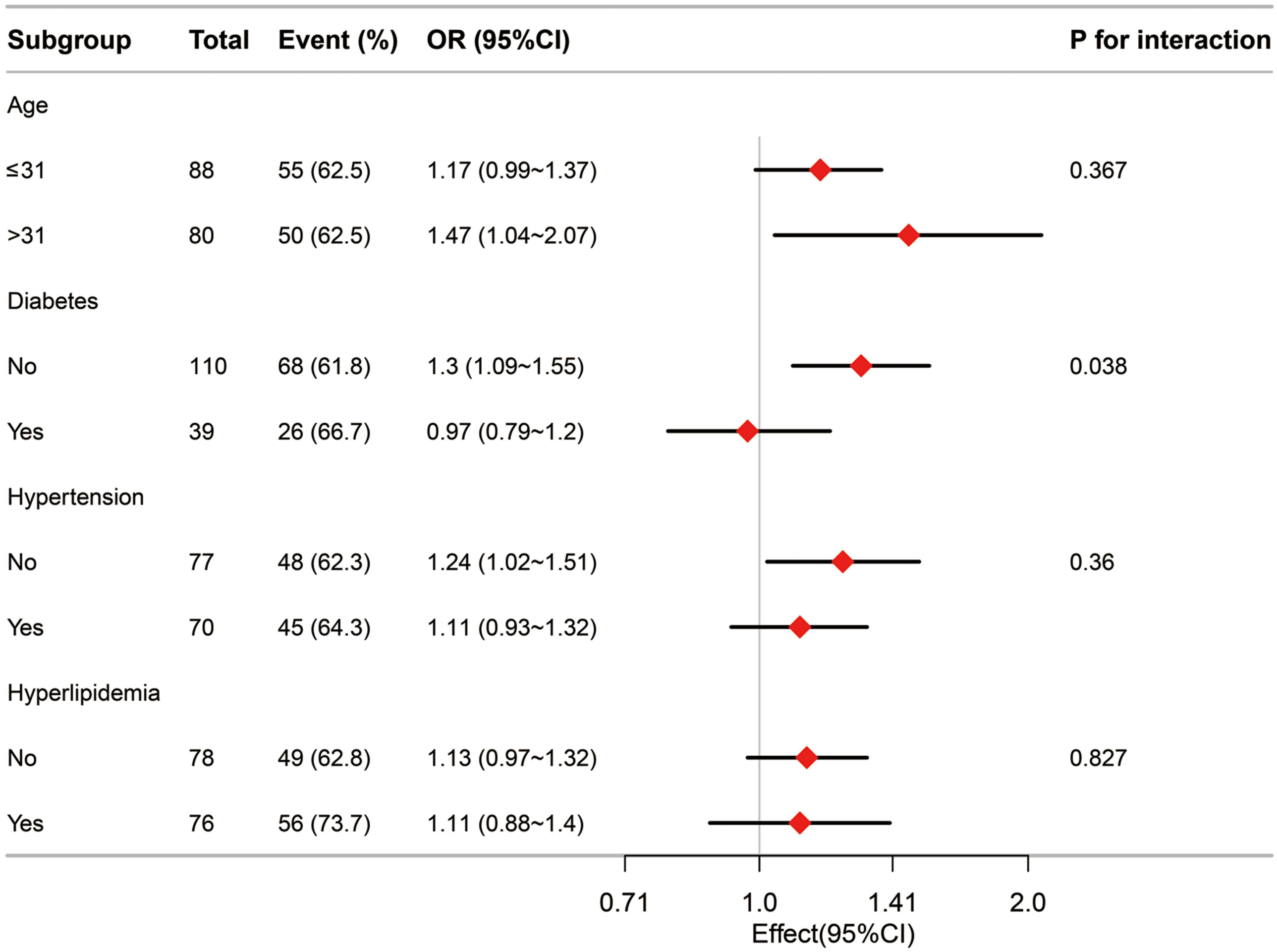

Figure 5 Subgroup analysis of the association between RFM and the risk of hyperuricemia. The data shown in the figure are stratified by sociodemographic characteristics and common obesity-related comorbidities.
Abbreviation: RFM, relative fat mass.

revealed that increasing levels of both the C-index and RFM were associated with a stepwise elevation in HUA risk. However, the nonlinearity tests for both variables were not statistically significant ($p > 0.05$), indicating that the associations are best described by linear models. These findings suggest that, within the studied population, the risk of HUA increases in a linear fashion with rising C-index and RFM levels.

Stratified Analyses

Stratified analyses were conducted to assess the association between RFM and hyperuricemia (HUA) across subgroups defined by age, hypertension, and hyperlipidemia status among obese patients with PCOS. As shown in Figure 5, the positive association between RFM and HUA remained consistent across all subgroups, with no significant interactions detected (all p for interaction > 0.05). Notably, a potential interaction was observed with diabetes status, suggesting that the relationship between RFM and HUA risk may be modified in the presence of diabetes.

Discussion

This study provides valuable insights into the complex interplay between obesity, PCOS, and HUA, emphasizing the unique metabolic risks associated with these overlapping conditions. The findings align with prior research, highlighting the fact that the pathophysiology of PCOS, which is characterized by hyperandrogenism, insulin resistance, and chronic low-grade inflammation, is amplified both by obesity and its related comorbidities.[14–16] HUA, a known marker of metabolic dysfunction, has been identified as an independent risk factor for various conditions, including cardiovascular disease, insulin resistance, and systemic inflammation, all of which are exacerbated in obese individuals with PCOS.[17–19]

The pathophysiology linking obesity, PCOS, and HUA involves several overlapping mechanisms. For example, insulin resistance, which is a hallmark of both PCOS and obesity, plays a pivotal role by impairing renal urate excretion via downregulation of sodium–urate cotransporters in the proximal renal tubules.[4,20] Hyperinsulinemia further exacerbates uric acid retention, contributing to the development of HUA,[21,22] and obesity amplifies this effect, with excess adipose tissue promoting chronic inflammation and oxidative stress through increased secretion of adipokines, such as leptin and resistin, as well as pro-inflammatory cytokines, including tumor necrosis factor alpha (TNF-α) and interleukin six (IL-6).[23,24]

Obesity is associated with increased expression and activity of xanthine oxidoreductase (XOR) in adipose tissue, which contributes to enhanced uric acid production. Visceral adipose depots, in particular, exhibit stress-responsive XOR activation, linking excessive fat accumulation to oxidative stress and hyperuricemia.[25,26] These adiposity-driven mechanisms may underlie our observation that obese women with PCOS exhibit a significantly higher prevalence of hyperuricemia compared with their obese non-PCOS counterparts.

Additionally, HUA may exacerbate the pathogenesis of PCOS through its pro-oxidative effects. For instance, uric acid functions as a danger signal within the inflammatory cascade, enhancing oxidative stress and promoting mitochondrial dysfunction in granulosa cells, thereby impairing follicular development and ovulatory function.[19,27] Furthermore, HUA-induced systemic inflammation may contribute to endothelial dysfunction, which is commonly observed in those with PCOS and has been linked to increased cardiovascular risks.[27,28] In summary, the interplay between insulin resistance, chronic inflammation, and oxidative stress establishes bidirectional relationships between obesity, PCOS, and HUA, creating a pathogenic cycle that may perpetuate metabolic dysfunction and reproductive disturbances.

Traditional metrics like the BMI are insufficient for accurately assessing the metabolic risks associated with PCOS with comorbid obesity, as they fail to capture information on fat distribution or composition. In contrast, RFM and the C-index are metrics that facilitate more refined assessments of adiposity and its metabolic consequences. RFM, which incorporates height measurements and WC, demonstrated a robust association with HUA in the present study, and the linear relationship observed in the RCS analysis reinforces its predictive validity for the development of HUA, particularly in populations with severe obesity. Previous research has also highlighted the superiority of RFM over the BMI as an indicator of cardiometabolic risk, underscoring its relevance for clinical applications in patients with obesity.[29] The C-index, while also reflective of central obesity, exhibited a weaker association with the occurrence of HUA in this cohort. This discrepancy may be attributed to the differential sensitivity of the two indices to total versus central adiposity, with RFM being more sensitive to variations in total fat mass.[30,31] Collectively, these findings suggest that RFM may be more applicable in severely obese populations in whom overall adiposity plays a dominant role in metabolic dysfunction.

The subgroup analysis revealed that the presence of diabetes modulated the relationship between RFM and HUA, which is consistent with the known impact of diabetes on uric acid metabolism through mechanisms that involve hyperglycemia-induced oxidative stress, altered renal clearance, and the production of advanced glycation end products (AGEs).[32,33] Hyperglycemia and insulin resistance further exacerbate oxidative stress, creating a feedback loop that promotes both the occurrence of HUA and metabolic dysfunction.[34] These observations underscore the importance of stratifying analyses by diabetes status in studies investigating obesity-related indices and their metabolic sequelae. Future research should explore how targeted interventions for glycemic control could mitigate the risk of HUA in obese patients with PCOS.

The identification of a strong association between RFM and HUA has important clinical implications, as incorporating advanced adiposity indices, such as RFM, into routine evaluations of obese patients with PCOS could facilitate the identification of individuals with a high susceptibility for HUA and its associated complications, including cardiovascular disease and insulin resistance. Such risk stratification may inform individualized management strategies, including dietary and lifestyle interventions aimed at reducing adiposity and serum uric acid levels. Furthermore, although current PCOS management guidelines highlight the importance of early detection of metabolic complications, they offer limited recommendations for evaluating adiposity beyond BMI. Incorporating RFM as an additional measure may strengthen clinical screening, particularly in light of emerging evidence that reducing uric acid levels can yield metabolic benefits in individuals at elevated risk.[4]

Despite the strengths, this study does have some limitations. First, the cohort was limited to individuals who were severely obese, meaning the findings may not be generalizable to non-obese or less obese populations. Second, the cross-sectional design precludes causal inferences regarding the relationships between obesity indices and the occurrence of HUA. Third, despite adjusting for potential confounders, some residual confounding variables may not have been controlled for, particularly with respect to dietary and genetic factors that can influence uric acid levels. Future longitudinal studies are warranted to validate the present findings and elucidate the causal pathways linking RFM, HUA, and PCOS. Additionally, mechanistic research exploring the role of uric acid in ovarian dysfunction and systemic inflammation may provide deeper insights into the interplay among these conditions, and interventional studies assessing the impact of targeted therapies, such as urate-lowering agents or adiposity reduction strategies, could further inform clinical decision-making.

Conclusions

This study demonstrates a robust association between relative fat mass (RFM) and hyperuricemia (HUA) in obese women with PCOS, with RFM outperforming the C-index as a predictor. These findings underscore the value of incorporating RFM into routine metabolic assessments, enabling more precise risk stratification and the identification of individuals at heightened risk of HUA and related metabolic disturbances. Integrating RFM into clinical practice may facilitate earlier and more targeted interventions for this high-risk population.

Abbreviations

95% CI, 95% confidence interval; AGEs, advanced glycation end products; ANOVA, analysis of variance; BMI, body mass index; C-index, conicity index; DBP, diastolic blood pressure; FINS, fasting insulin; FPG, fasting plasma glucose; HbA1c, hemoglobin A1c; HDL-c, high-density lipoprotein cholesterol; HUA, hyperuricemia; IL-6, interleukin six; IQR, interquartile range; LDL-c; OGTT, oral glucose tolerance test; OR, odds ratio; PCOS, polycystic ovary syndrome; RCS, restricted cubic spline; RFM, relative fat mass; SBP, systolic blood pressure; SD, standard deviation; TNF-α, tumor necrosis factor alpha; WHO, World Health Organization.

Data Sharing Statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

The study was approved by the institutional Clinical Ethics Committee of the Taixing People's hospital (Clinical Registration Number: LS2025015). It was conducted in accordance with the Declaration of Helsinki and the Guidelines for Good Clinical Practice. All participants gave written informed consent before taking part in the study.

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Author Contributions

LZ: conceptualization, supervision, formal analysis, writing – review and editing. ZH: methodology, writing – original draft, conceptualization, writing – review and editing. QL: validation, data curation, formal analysis, writing – review and editing. LW: investigation, data curation, formal analysis, writing – review and editing. YJ: formal analysis, writing – review and editing.

All authors 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 no conflicts of interest.

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