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The Association Between Hyperuricemia and Hematological Indicators in a Chinese Adult Population

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Abstract: The aim of this study was to explore the relationship between hyperuricemia and hematological indicators.

Five hundred twenty-two male and 255 female subjects (18–90 years old) were recruited in the study. The level of serum uric acid (SUA), total white blood cell (WBC) count, red blood cell (RBC) count, hemoglobin, hematocrit, and platelet count was measured, computed, and analyzed. Pearson correlation coefficients, Student *t*-tests, multivariate linear regression models, and multivariate logistic regression models were performed to analyze the results.

For men, WBC count ($r = 0.13$, $P < 0.01$), RBC count ($r = 0.15$, $P < 0.001$), and hemoglobin ($r = 0.11$, $P < 0.05$) were significantly correlated with SUA. For women, WBC count ($r = 0.24$, $P < 0.001$), RBC count ($r = 0.31$, $P < 0.001$), hemoglobin ($r = 0.31$, $P < 0.001$), and hematocrit ($r = 0.29$, $P < 0.001$) were significantly correlated with SUA. For men, WBC ($P < 0.01$) and RBC ($P < 0.05$) counts were significantly higher in patients with hyperuricemia than in normal subjects. For men, after adjustment for confounding factors, those in the fourth quartiles of WBC counts had 1.66-fold increased odds of hyperuricemia as compared with those in the reference group. For women, after adjustment, those in the second to fourth quartiles of WBC count, RBC count, hemoglobin, and hematocrit had increased the odds of hyperuricemia as compared with those in the reference groups.

Our study showed significant relations between the level of SUA and WBC count, RBC count, hemoglobin, and hematocrit, which could be important biological markers of hyperuricemia.

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Abbreviations: BMI = body mass index, Chol = cholesterol, CI = confidence interval, CRP = C-reactive protein, CVDs = cardiovascular diseases, DBP = diastolic blood pressure, Glu = glucose, Hb = hemoglobin, Hct = hematocrit, IL-6 = interleukin-6, OR = odds ratio, RBC = red blood cell, SBP = systolic blood pressure, SD = standard deviation, SUA = serum uric acid, TG = triglyceride, WBC = white blood cell.

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INTRODUCTION

Hyperuricemia is defined as serum uric acid (SUA) ≥7.0 mg/dL for men and SUA ≥6.0 mg/dL for women, which is caused by accelerated generation of uric acid and/or impaired excretion in the kidney.[1–5] In recent decades, the prevalence of hyperuricemia has been growing worldwide as well as in China.[6–9]

Epidemiological studies showed that uric acid was a risk factor for cardiovascular diseases (CVDs) and was positively associated with proinflammatory markers. When analyses were performed to determine the independent predictors of inflammatory cells in blood, a strong, positive, and independent relationship between SUA and white blood cell (WBC) count, neutrophils, monocytes, C-reactive protein (CRP), and interleukin-6 (IL-6) was found.[10–13] One of the causes for hyperuricemia was an increased synthesis of nucleic acids occurring as part of the erythropoietic response to hemolysis in hemoglobin disorders.[14] Also, both of the baseline SUA level and SUA slope were significantly associated with the hematocrit level.[15] Significant relations were observed between SUA concentration and platelet volume, platelet reactivity, platelet count, and platelet abnormalities, but not with platelet aggregation.[16–19]

However, there were few references studying the relationship between hyperuricemia and hematological indicators. In the present study, we evaluated indicators of hemocytes and studied the association of SUA level with these indicators.

METHODS

Subjects

Subjects were citizens of Bejing, China, some of whom came from healthy residents receiving annual checkup in Xiehe Hospital, and others came from the community population. Data were provided by Chinese Hyperuricemia and Gout Database, a part of Chinese National Scientific Data Sharing Platform for Population and Health. The database is a cross-sectional investigation, which collects information from the healthy population. The subjects include annual check-up citizens from Xiehe Hospital as well as part of citizens from the community. The purpose of this database is to collect the epidemiological data of hyperuricemia and gout patients, calculate the prevalence of hyperuricemia and gout in Beijing, China, investigate the risk factors for the development of hyperuricemia and gout, and analyze the associations between hyperuricemia and gout and CVDs. The database builds a foundation for the epidemiological study of hyperuricemia and gout, and provides data for improving the health management of hyperuricemia patients, standardizing the clinical guideline for the diagnosis and treatment of gout, and helping researchers on medical studies and public health. A total number of 940 subjects were recruited in the study. After exclusion of those with missing data, 777 subjects consisting of 522 male (61 hyperuricemia and 461

normal) and 255 female (18 hyperuricemia and 237 normal) participants were calculated in the study, and their ages ranged from 18 to 90 years.

Measures

Blood sample was taken from participants when they were fasting. For men, hyperuricemia was defined as SUA $\geq$7.0 mg/dL, while for women it was defined as SUA $\geq$6.0 mg/dL.[2] Total WBC count, red blood cell (RBC) count, the level of hemoglobin, the level of hematocrit, and platelet count were evaluated, computed, and analyzed. WBC count was measured to the nearest 0.01*10^9/L; RBC count was measured to the nearest 0.01*10^12/L; hemoglobin level was measured to the nearest 1 g/L; hematocrit level was measured to the nearest 0.1%; platelet count was measured to the nearest 10^9/L.

Statistical Analyses

Continuous variables were expressed as mean ± SD (standard deviation). The correlation of SUA concentration and hematological parameters was tested by Pearson correlation coefficients. The comparisons between patients with hyperuricemia and normal subjects were computed by Student *t*-tests. Multivariate linear regression models were used for continuous variables, while multivariate logistic regression models were applied for categorical variables. In all cases, $P < 0.05$ was considered as the level of significance.

Ethical Standards

The data used in this study were based on Chinese Hyperuricemia and Gout Database, provided by the Chinese National Scientific Data Sharing Platform for Population and Health. Protocols used in this database were approved by the Ethics Committee of the Chinese National Scientific Data Sharing Platform for Population and Health.

RESULTS

In Table 1, Pearson correlation coefficients of SUA concentration with hematological parameters were performed.

TABLE 1. Pearson Correlation Coefficients of Serum Uric Acid With Hematological Parameters

	Men		Women	
	r	*P*	*r*	*P*
SUA	1		1	
Age	−0.09	0.042*	0.28	0.000***
WBC	0.13	0.003**	0.24	0.000***
RBC	0.15	0.000***	0.31	0.000***
Hemoglobin	0.11	0.011*	0.31	0.000***
Hematocrit	0.07	0.109	0.29	0.000***
Platelet	0.05	0.231	0.01	0.922

RBC = red blood cell, SUA = serum uric acid, WBC = white blood cell.
* $P < 0.05$.
** $P < 0.01$.
*** $P < 0.001$.

For men, the total WBC count ($r = 0.13$, $P < 0.01$), RBC count ($r = 0.15$, $P < 0.001$), hemoglobin ($r = 0.11$, $P < 0.05$) were all significantly correlated with SUA concentration. For women, the positively associated hematological parameters included WBC count ($r = 0.24$, $P < 0.001$), RBC count ($r = 0.31$, $P < 0.001$), hemoglobin ($r = 0.31$, $P < 0.001$), and hematocrit ($r = 0.29$, $P < 0.001$), but not platelet ($r = 0.01$, $P = 0.922$).

Table 2 showed the comparison of hematological parameters between hyperuricemia and normal subjects. For men, WBC and RBC counts were significantly higher in patients with hyperuricemia than in the normal subjects. For women, WBC count, RBC count, hemoglobin, and hematocrit were all significantly higher in patients with hyperuricemia than in the normal subjects. However, as the number of hyperuricemia women was small (18), the significance of the relations would be further discussed according to other analyses in the following paragraphs.

TABLE 2. The Comparison of Hematological Parameters Between Hyperuricemia and Normal Subjects in Both Genders

		Men					Women				
		Hyperuricemia		Normal			Hyperuricemia		Normal		
	Unit	Mean	SD	Mean	SD	*P*	Mean	SD	Mean	SD	*P*
Number (%)		61 (11.7%)		461 (88.3%)			18 (7.1%)		237 (92.9%)		
SUA	mg/dL	7.75	0.69	5.34	0.92	0.000***	6.52	0.43	3.97	0.85	0.000***
Age	yrs	46.14	14.95	47.10	16.43	0.627	60.61	14.74	45.76	16.78	0.001**
WBC	10^9/L	7.33	1.63	6.71	1.65	0.007**	7.32	1.31	6.14	1.37	0.001**
RBC	10^12/L	5.24	0.47	5.08	0.41	0.013*	4.70	0.43	4.43	0.35	0.017*
Hemoglobin	g/L	157.23	8.16	155.16	10.61	0.077	142.33	11.73	132.37	10.28	0.002**
Hematocrit	%	44.97	2.31	44.42	2.88	0.095	40.88	3.25	38.63	2.70	0.010*
Platelet	10^9/L	237.13	40.75	232.54	56.51	0.433	241.83	41.58	255.64	57.32	0.201

RBC = red blood cell, SD = standard deviation, SUA = serum uric acid, WBC = white blood cell.
* $P < 0.05$.
** $P < 0.01$.
*** $P < 0.001$.

Table 3 showed results of multivariate linear regression models, which demonstrated referencing linear formulas as follows:

For men,

$$SUA = 0.004*Chol + 0.002*TG - 0.007*Glu + 0.069*WBC + 0.434*RBC - 0.104*Hct$$

For women,

$$SUA = 0.003*TG + 0.705*RBC + 0.034*Hb$$

(Chol = cholesterol, Glu = glucose, Hb = hemoglobin, Hct = hematocrit, RBC = red blood cell, TG = triglyceride, WBC = white blood cell).

Table 4 and Table 5 showed the relationship between SUA concentration and hematological parameters. By multivariate logistic regression models (Model 1 to Model 8), a lot of confounding factors were adjusted, including age, body mass index (BMI), systolic blood pressure (SBP), diastolic blood pressure (DBP), cholesterol, triglyceride, and glucose. For men, after adjustment, those in the fourth quartiles of WBC counts had 1.66-fold increased odds of hyperuricemia as compared with those in the reference group. For women, after adjustment, those in the second to fourth quartiles of WBC counts had 1.77 to 2.82-fold increased odds of hyperuricemia as compared with those in the reference group. Those in the second to third quartiles of RBC counts had 1.50 to 2.27-fold increased odds of hyperuricemia as compared with those in the reference group. Those in the third to fourth quartiles of hemoglobin had 2.21 to 3.18-fold increased odds of hyperuricemia as compared with those in the reference group. And, those in the second quartiles of hematocrit had 2.19-fold increased odds of hyperuricemia as compared with those in the reference group.

In Table 2, compared with normouricemia women, hyperuricemia women had higher levels of WBC count, RBC count, hemoglobin, and hematocrit. However, the small sample of hyperuricemia women (18) might affect the significance of the results and cause a big difference on ages (60.61 vs. 45.76). Furthermore, we analyzed the level of SUA in all of the female participants (255). Depending on Pearson correlation test, WBC count, RBC count, hemoglobin, and hematocrit were related to the level of SUA. Considering that other factors (age, height, weight, BMI, SBP, DBP, cholesterol, triglyceride, and glucose) might affect the results, we performed both multivariate linear and logistic regression models to retest the results. In multivariate linear regression models, with the entrance of these factors, triglyceride, RBC count, and hemoglobin showed significant associations with the level of SUA. In multivariate logistic regression models, after the adjustment of age, WBC count, RBC count, hemoglobin, and hematocrit showed significant associations with the level of SUA. After the adjustments of age, triglyceride, and other factors, the associations of WBC count, RBC count, hemoglobin, and hematocrit were significant. According to all the results, RBC count and hemoglobin were significantly associated with the level of SUA in women, and the count of platelet showed a negative correlation with the levels of SUA in all models.

TABLE 3. The Relationship Between Serum Uric Acid Concentration and Hematological Parameters With Various Confounding Factors by Multivariate Linear Regression Models

		Men		Women	
	Unit	**beta**	***P***	**beta**	***P***
R^2		0.153		0.295	
Constant		1.007	0.935	4.704	0.619
Age	yrs	−0.003	0.488	0.007	0.172
Height	cm	0.014	0.846	−0.033	0.583
Weight	kg	0.014	0.872	0.068	0.393
BMI	kg/m^2	−0.002	0.994	−0.126	0.529
SBP	mm Hg	0.004	0.388	0.010	0.094
DBP	mm Hg	0.010	0.179	−0.015	0.112
Cholesterol	mg/dL	0.004	0.033*	0.003	0.174
Triglyceride	mg/dL	0.002	0.010*	0.003	0.011*
Glucose	mg/dL	−0.007	0.001**	−0.004	0.395
WBC	10^9/L	0.069	0.045*	0.082	0.076
RBC	10^12/L	0.434	0.036*	0.705	0.013*
Hemoglobin	g/L	0.014	0.305	0.034	0.041*
Hematocrit	%	−0.104	0.040*	−0.138	0.053
Platelet	10^9/L	−0.001	0.182	−0.0002	0.859

BMI = body mass index, DBP = diastolic blood pressure, RBC = red blood cell, SBP = systolic blood pressure, WBC = white blood cell.

* $P < 0.05$.

** $P < 0.01$.

DISCUSSION

According to our results, there was a significant relationship between hyperuricemia and hematological indicators for both genders. The subjects with higher SUA concentration tended to get higher levels of hematological parameters. On the contrary, those subjects with higher levels of hematological parameters were easier to be diagnosed with hyperuricemia. Compared with normouricemia men, hyperuricemia men had higher levels of WBC and RBC counts. After adjustment, SUA concentration was significantly associated with WBC count in men, and showed strong relations with WBC count, RBC count, hemoglobin, and hematocrit in women. In both men and women, there were no significant correlations between SUA level and platelet count.

According to references, a strong positive independent relationship between SUA and circulating inflammatory cell counts was found by performing multiple linear regression analysis.[10] Those positive cell counts included WBC count ($\beta \pm SE$ [β-coefficient ± standard error]: 257 ± 66, $P < 0.001$), neutrophils ($\beta \pm SE$: 206 ± 60, $P < 0.001$), and monocyte count ($\beta \pm SE$: 35 ± 7, $P < 0.001$), but not lymphocyte count ($\beta \pm SE$: 25 ± 23, $P = 0.275$). When patients were divided into 4 groups according to the quartiles of SUA, it was found that the monocyte count was prominently related with SUA ($\beta \pm SE$: 478 ± 165, 553 ± 177, 565 ± 199, and 607 ± 229, $P < 0.001$). Relations between SUA level with CRP and IL-6 were likewise detected.[11] Subjects with high uric acid at baseline had a progressively higher probability of developing clinically relevant increased IL-6 (>2.5 pg/mL) and CRP (>3 mg/L) during 3 years. In our research, for both genders, hyperuricemia subjects had a higher level of WBC count than those in the control group, which might indicate that SUA level was involved in inflammatory processes.

There were statistically significant positive correlations between SUA level and RBC count ($P < 0.001$), hemoglobin ($P < 0.001$), and hematocrit ($P < 0.001$).[20] The development of hyperuricemia also generated from an increased synthesis of nucleic acids occurring as part of the erythropoietic response to hemolysis in hemoglobin disorders such as sickle cell anemia, α-thalassemia, and β-thalassemia.[14] The hematocrit level was significantly correlated with the baseline SUA level ($r = 0.139$,

TABLE 4. The Relationship Between Serum Uric Acid Concentration and Hematological Parameters by Multivariate Logistic Regression Models After Adjustments for Confounding Factors in Men

		Model 1				Model 2				Model 3				Model 4			
		OR	95% CI		P	OR	95% CI		P	OR	95% CI		P	OR	95% CI		P
WBC	(10^9/L)																
	<4.60	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—
	4.61–5.80	1.39	0.93	2.07	0.104	1.42	0.93	2.17	0.106	1.41	0.90	2.20	0.132	1.50	0.96	2.36	0.078
	5.81–7.10	1.54	1.04	2.27	0.031*	1.53	1.01	2.32	0.047*	1.49	0.96	2.31	0.078	1.54	0.98	2.42	0.060
	>7.1	1.82	1.23	2.69	0.003**	1.84	1.21	2.79	0.004**	1.73	1.12	2.69	0.014*	1.77	1.13	2.78	0.012*
RBC	(10^12/L)																
	<5.20	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—
	5.21–5.50	1.06	0.90	1.27	0.480	1.03	0.86	1.24	0.755	0.98	0.80	1.19	0.823	0.98	0.80	1.20	0.839
	5.51–5.80	1.20	0.95	1.51	0.127	1.16	0.90	1.51	0.258	1.12	0.85	1.47	0.416	1.13	0.86	1.49	0.388
	>5.81	1.64	1.14	2.36	0.008**	1.69	1.14	2.52	0.010*	1.56	1.01	2.40	0.043*	1.60	1.03	2.49	0.036*
Hemoglobin	(g/L)																
	<158.0	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—
	158.1–164.0	1.24	1.04	1.49	0.019*	1.21	1.01	1.46	0.042*	1.14	0.94	1.39	0.188	1.16	0.95	1.42	0.146
	164.1–172.0	1.01	0.81	1.26	0.922	0.95	0.75	1.20	0.671	0.91	0.71	1.16	0.440	0.91	0.71	1.17	0.476
	>172.1	1.35	0.93	1.95	0.112	1.31	0.88	1.95	0.179	1.39	0.90	2.15	0.134	1.39	0.89	2.17	0.146
Hematocrit	(%)																
	<45.60	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—
	45.61–48.00	1.04	0.88	1.22	0.680	1.01	0.85	1.20	0.918	1.00	0.83	1.20	0.986	1.01	0.84	1.22	0.925
	48.01–50.40	0.85	0.64	1.13	0.270	0.82	0.60	1.10	0.184	0.77	0.56	1.04	0.090	0.77	0.56	1.04	0.090
	>50.41	1.16	0.68	2.00	0.585	1.10	0.62	1.95	0.753	1.30	0.68	2.50	0.424	1.34	0.69	2.60	0.382
Platelet	(10^9/L)																
	<171.0	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—
	171.1–206.0	1.36	1.04	1.78	0.025*	1.30	0.99	1.71	0.062	1.36	1.00	1.86	0.048	1.33	0.97	1.82	0.072
	206.1–243.0	1.25	0.96	1.63	0.091	1.20	0.92	1.57	0.178	1.31	0.97	1.77	0.079	1.27	0.94	1.72	0.124
	>243.1	1.39	1.08	1.79	0.010*	1.31	1.02	1.69	0.037*	1.29	0.97	1.72	0.084	1.25	0.94	1.68	0.130

		Model 5				Model 6				Model 7				Model 8			
		OR	95% CI		P	OR	95% CI		P	OR	95% CI		P	OR	95% CI		P
WBC	(10^9/L)																
	<4.60	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—
	4.61–5.80	1.53	0.96	2.42	0.072	1.50	0.94	2.41	0.091	1.46	0.89	2.38	0.132	1.49	0.91	2.46	0.115
	5.81–7.10	1.56	0.99	2.47	0.056	1.52	0.95	2.43	0.081	1.44	0.88	2.35	0.145	1.48	0.90	2.43	0.126
	>7.1	1.78	1.13	2.81	0.013*	1.72	1.07	2.75	0.024*	1.63	1.00	2.66	0.052	1.66	1.01	2.75	0.046*
RBC	(10^12/L)																
	<5.20	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—
	5.21–5.50	0.98	0.80	1.20	0.852	0.97	0.80	1.19	0.804	0.95	0.77	1.17	0.609	0.94	0.77	1.17	0.592
	5.51–5.80	1.13	0.85	1.49	0.395	1.10	0.83	1.46	0.509	1.08	0.80	1.44	0.622	1.07	0.80	1.43	0.639
	>5.81	1.60	1.03	2.49	0.037*	1.44	0.91	2.29	0.118	1.36	0.84	2.19	0.210	1.34	0.83	2.16	0.226
Hemoglobin	(g/L)																
	<158	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—
	158–164	1.16	0.94	1.42	0.162	1.15	0.93	1.41	0.189	1.13	0.91	1.39	0.271	1.12	0.91	1.39	0.296
	164–172	0.91	0.71	1.17	0.467	0.87	0.68	1.13	0.299	0.84	0.65	1.09	0.182	0.84	0.64	1.08	0.178
	>172	1.46	0.91	2.33	0.116	1.46	0.90	2.35	0.121	1.36	0.84	2.22	0.213	1.36	0.84	2.23	0.213
Hematocrit	(%)																
	<45.60	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—
	45.61–48.00	1.01	0.84	1.22	0.916	1.00	0.83	1.21	0.982	1.00	0.82	1.22	0.981	1.00	0.82	1.22	0.998
	48.01–50.40	0.77	0.56	1.05	0.094	0.75	0.55	1.02	0.068	0.73	0.53	1.01	0.056	0.74	0.54	1.02	0.062
	>50.41	1.37	0.69	2.75	0.367	1.38	0.69	2.78	0.364	1.33	0.65	2.72	0.433	1.31	0.64	2.71	0.458
Platelet	(10^9/L)																
	<171.0	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—
	171.1–206.0	1.31	0.96	1.79	0.088	1.31	0.95	1.81	0.104	1.32	0.95	1.84	0.096	1.31	0.94	1.83	0.111
	206.1–243.0	1.27	0.93	1.72	0.129	1.27	0.92	1.74	0.144	1.24	0.90	1.72	0.182	1.22	0.88	1.69	0.224
	>243.1	1.24	0.92	1.66	0.157	1.22	0.90	1.66	0.192	1.19	0.87	1.62	0.280	1.17	0.85	1.59	0.336

BMI = body mass index, CI = confidence interval, DBP = diastolic blood pressure, OR = odds ratio, RBC = red blood cell, SBP = systolic blood pressure, WBC = white blood cell. Model1 = unadjusted, Model2 = adjusted for age, Model3 = adjusted for age, and BMI, Model4 = adjusted for age, BMI and SBP, Model5 = adjusted for age, BMI, SBP and DBP, Model6 = adjusted for age, BMI, SBP, DBP and cholesterol, Model7 = adjusted for age, BMI, SBP, DBP, cholesterol and triglyceride, Model8 = adjusted for age, BMI, SBP, DBP, cholesterol, triglyceride and glucose.

* $P < 0.05$.
** $P < 0.01$. *** $P < 0.001$.

TABLE 5. The Relationship Between Serum Uric Acid Concentration and Hematological Parameters by Multivariate Logistic Regression Models After Adjustments for Confounding Factors in Women

		Model 1				Model 2				Model3				Model 4			
		OR	95% CI		P	OR	95% CI		P	OR	95% CI		P	OR	95% CI		P
WBC	(10^9/L)																
	<4.50	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—
	4.51–5.90	1.68	1.03	2.74	0.036*	1.75	1.05	2.92	0.031*	1.71	1.02	2.87	0.041*	1.80	1.06	3.06	0.031*
	5.91–7.40	2.21	1.36	3.60	0.001**	2.27	1.36	3.82	0.002**	2.03	1.20	3.45	0.008**	2.27	1.31	3.93	0.003**
	>7.41	2.50	1.50	4.17	0.000***	2.89	1.67	5.01	0.000***	2.81	1.60	4.94	0.000***	3.02	1.69	5.40	0.000***
RBC	(10^12/L)																
	<4.60	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—
	4.61–4.85	1.53	1.12	2.08	0.007**	1.56	1.12	2.17	0.009**	1.56	1.10	2.22	0.013*	1.53	1.07	2.19	0.019*
	4.86–5.10	1.79	1.15	2.78	0.010*	2.19	1.32	3.65	0.002**	2.34	1.38	3.99	0.002**	2.36	1.39	4.00	0.001**
	>5.11	2.15	1.11	4.16	0.023*	2.10	1.03	4.30	0.042*	2.22	1.01	4.86	0.047*	1.52	0.57	4.01	0.402
Hemoglobin	(g/L)																
	<136.0	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—
	136.1–142.0	1.15	0.84	1.57	0.393	1.09	0.78	1.53	0.607	1.56	1.12	2.17	0.009	1.08	0.76	1.53	0.686
	142.1–150.0	2.19	1.52	3.18	0.000***	2.23	1.49	3.35	0.000***	2.19	1.32	3.65	0.002**	2.15	1.40	3.30	0.000***
	>150.1	2.32	1.27	4.23	0.006**	2.72	1.34	5.52	0.006**	2.10	1.03	4.30	0.042*	3.00	1.37	6.58	0.006**
Hematocrit	(%)																
	<40.00	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—
	40.01–42.40	1.17	0.86	1.58	0.318	1.08	0.78	1.49	0.637	1.07	0.76	1.50	0.695	1.10	0.78	1.55	0.593
	42.41–45.00	2.27	1.51	3.40	0.000***	2.20	1.41	3.43	0.001**	2.08	1.31	3.30	0.002**	2.07	1.30	3.29	0.002**
	>45.01	3.52	1.02	12.15	0.046*	3.63	0.95	13.90	0.060	3.47	0.25	47.52	0.351	3.47	0.25	47.49	0.351
Platelet	(10^9/L)																
	<187.0	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—
	187.1–224.0	0.63	0.41	0.98	0.042*	0.63	0.39	1.00	0.051	0.58	0.35	0.97	0.038*	0.57	0.34	0.97	0.036*
	224.1–263.0	0.71	0.47	1.08	0.106	0.78	0.49	1.24	0.290	0.79	0.48	1.28	0.333	0.79	0.48	1.30	0.351
	>263.1	0.85	0.57	1.24	0.394	0.92	0.60	1.41	0.705	0.90	0.57	1.41	0.644	0.93	0.58	1.47	0.743

		Model 5				Model 6				Model 7				Model 8			
		OR	95% CI		P	OR	95% CI		P	OR	95% CI		P	OR	95% CI		P
WBC	(10^9/L)																
	<4.50	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—
	4.51–5.90	1.81	1.06	3.09	0.031*	1.84	1.07	3.17	0.028*	1.78	1.03	3.06	0.038*	1.77	1.02	3.06	0.042*
	5.91–7.40	2.29	1.32	3.97	0.003**	2.25	1.28	3.95	0.005**	2.20	1.25	3.86	0.006**	2.18	1.23	3.84	0.007**
	>7.41	3.01	1.68	5.40	0.000***	3.00	1.66	5.44	0.000***	2.76	1.51	5.01	0.001**	2.82	1.54	5.16	0.001**
RBC	(10^12/L)																
	<4.60	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—
	4.61–4.85	1.54	1.08	2.20	0.018*	1.50	1.04	2.16	0.032*	1.45	1.00	2.11	0.050	1.50	1.02	2.19	0.038*
	4.86–5.10	2.38	1.40	4.05	0.001**	2.40	1.41	4.08	0.001**	2.38	1.40	4.06	0.001**	2.27	1.32	3.90	0.003**
	>5.11	1.35	0.48	3.80	0.567	1.27	0.43	3.81	0.664	1.41	0.43	4.61	0.572	1.61	0.46	5.61	0.453
Hemoglobin	(g/L)																
	<136.0	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—
	136.1–142.0	1.08	0.76	1.54	0.664	1.01	0.70	1.46	0.939	0.97	0.67	1.42	0.887	0.96	0.66	1.40	0.827
	142.1–150.0	2.20	1.42	3.39	0.000***	2.09	1.35	3.24	0.001**	2.11	1.35	3.29	0.001**	2.21	1.40	3.49	0.001**
	>150.1	3.05	1.38	6.72	0.006**	2.92	1.31	6.52	0.009**	2.74	1.18	6.37	0.019*	3.18	1.31	7.73	0.011*
Hematocrit	(%)																
	<40.00	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—
	40.01–42.40	1.10	0.78	1.55	0.604	1.08	0.76	1.53	0.671	1.08	0.76	1.54	0.674	1.03	0.72	1.48	0.867
	42.41–45.00	2.11	1.31	3.39	0.002**	2.07	1.28	3.34	0.003**	2.00	1.22	3.27	0.006**	2.19	1.31	3.66	0.003**
	>45.01	3.55	0.26	48.78	0.344	3.61	0.26	49.84	0.337	6.50	0.02	229.00	0.942	2.19	0.07	652.00	0.967
Platelet	(10^9/L)																
	<187.0	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—	—
	187.1–224.0	0.57	0.34	0.96	0.036*	0.53	0.31	0.91	0.020*	0.56	0.32	0.96	0.035	0.56	0.32	0.97	0.039*
	224.1–263.0	0.79	0.48	1.30	0.353	0.69	0.41	1.16	0.160	0.73	0.43	1.23	0.234	0.73	0.43	1.25	0.252
	>263.1	0.93	0.58	1.48	0.752	0.88	0.55	1.40	0.582	0.91	0.56	1.46	0.685	0.89	0.55	1.45	0.645

BMI = body mass index, CI = confidence interval, DBP = diastolic blood pressure, OR = odds ratio, RBC = red blood cell, SBP = systolic blood pressure, WBC = white blood cell. Model1 = unadjusted, Model 2 = adjusted for age, Model 3 = adjusted for age, and BMI, Model 4 = adjusted for age, BMI and SBP, Model 5 = adjusted for age, BMI, SBP and DBP, Model 6 = adjusted for age, BMI, SBP, DBP and cholesterol, Model 7 = adjusted for age, BMI, SBP, DBP, cholesterol and triglyceride, Model 8 = adjusted for age, BMI, SBP, DBP, cholesterol, triglyceride and glucose.

* $P < 0.05$.

** $P < 0.01$.

*** $P < 0.001$.

$P < 0.001$) and SUA slope ($r = 2.164$, $P < 0.001$).[15] Also, studies showed significantly higher hemoglobin, hematocrit, and RBC count ($P < 0.001$, $P < 0.001$, and $P = 0.032$, respectively) in patients with metabolic syndrome than those without metabolic syndrome.[20] According to our results, hyperuricemia men had a higher level of RBC count than those in the control group. As for women, besides RBC count, hemoglobin and hematocrit were also higher in the hyperuricemia group than those in the control group.

However, the relation between SUA concentration and platelet count in our research was not significant, which was contrary to other studies. Studies had reported a significant correlation between SUA and platelet count and mean platelet volume.[18] In addition, several theories implicated that elevated SUA was a causative factor for increasing platelet reactivity, but SUA levels did not influence platelet aggregation.[17,19] A previous study observed a significant relationship between SUA and mean platelet volume, and this association was stronger in women than men.[18] Platelet abnormalities occurred with hyperuricemia. Altered platelet kinetics played a role in arterial thrombosis and possibly in the genesis of atherosclerosis.[16]

In fact, there were also some limitations in this study. In the results, there was a big difference between women of average ages with and without hyperuricemia. It might be because the sample of hyperuricemia women was a little small, which might affect the significance of the results. Therefore, the division of hyperuricemia and normouricemia women might make the results disputable. In addition, another possible explanation for this big difference on ages might be a possible higher prevalence of hyperuricemia in older women.[8,21]

The relationships between CVDs and hematological parameters have been observed early.[22,23] Now, hyperuricemia has been proved to be associated with the risk factors of CVDs.[24,25] The relationship between hyperuricemia and hematological parameters might partly explain the high incidence of hyperuricemia patients with CVDs. The mechanism might include oxidant production, inflammatory reaction, thrombosis formation, endothelial dysfunction altered rheological properties, and vascular resistances. In addition, hematological parameters are easily performed at laboratory examination, and they might potentially be used as biological markers for patients with risk of hyperuricemia or CVDs.

CONCLUSION

Our study showed significant relations between the level of SUA and WBC count, RBC count, hemoglobin, and hematocrit, which could be important biological markers of hyperuricemia.

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