

# Association analysis of peripheral blood monocyte level and dyslipidemia in patients with chronic schizophrenia

Luhua Chen<sup>1,2,#</sup>, Weichao Su<sup>2,#</sup>, Xinquan Xie<sup>2</sup>, Haiying Lin<sup>2</sup>, Fagen Zheng<sup>2</sup>, Jiaqiang Zeng<sup>2</sup>, Jindong Chen<sup>2</sup>, Xiaopeng Deng<sup>1,a,\*</sup>

<sup>1</sup>Health Science Center, Yangtze University, Mental Health Center of Yangtze University, Mental Health Institute of Yangtze University, Jingzhou Rongjun Special Care Hospital, Jingzhou Mental Health Center, Jingzhou, China

<sup>2</sup>Xiamen Xianyue Hospital, Xianyue Hospital Affiliated with Xiamen Medical College, Fujian Psychiatric Center, Fujian Clinical Research Center for Mental Disorders, Xiamen, China

<sup>a</sup>jzxlys@163.com

\*Corresponding author

#These authors contributed equally to this work.

**Abstract:** To investigate the peripheral blood cell count levels, especially the level of monocytes (MON), and the association with dyslipidemia in patients with chronic schizophrenia (CSCZ) and its clinical significance, a total of 150 patients with CSCZ who were long-term hospitalized, were selected and included in the disease group, and 100 healthy individuals selected in the control group. The differences in the levels of various peripheral blood cell counts indicators and lipid metabolism indicators between the two groups were compared. The relationships between 14 significant changes in peripheral blood cell counts indicators and CSCZ with dyslipidemia were explored using univariate and multivariate binary logistic regression analysis. The correlation between MON level and lipid indicators was also analyzed. There were significant differences in 14 peripheral blood cell counts indicators between CSCZ patients and healthy controls, with LYM% and RBC being significantly lower in the CSCZ, and WBC, MCV, RDW-SD, RDW-CV, PLT, PDW, MPV, PCT, MON#, and MON% being significantly higher. The levels of HDL-C, LDL-C, and CHO in CSCZ were lower than healthy controls significantly, while TG level was not statistically significant. The univariate binary logistic regression analysis showed that gender, HCT, HGB, MON#, and RBC were significantly associated with the risk of dyslipidemia in CSCZ. The multivariate analysis showed that an increase in MON# was significantly associated with the occurrence of dyslipidemia. Moreover, MON level was negatively correlated with HDL-C concentration and positively correlated with TG concentration. In conclusion, the levels of peripheral blood counts and lipid metabolism of CSCZ patients were significantly different from healthy controls. HCT, HGB, MON, and RBC may play an important role in the pathogenesis of CSCZ, and the level of MON may be related to dyslipidemia in CSCZ. The detection of MON level is important for the auxiliary diagnosis of CSCZ.

**Keywords:** Chronic Schizophrenia; Complete Blood Cell Counts; Dyslipidemia; Monocyte; Logistic Regression Analysis

## 1. Introduction

Schizophrenia (SCZ) is one of the most common and severe mental disorders globally, with a lifetime prevalence of 1% that significantly impacts patients' lives. Some patients with chronic schizophrenia (CSCZ) are long-term residents in hospital wards, which imposes a heavy burden on individuals, families, and society [1-2], and they must take atypical antipsychotic drugs for a long time, during which the long-term use of drugs may lead to metabolic disorders in the body [3]. CSCZ patients with abnormal lipid metabolism may exhibit symptoms such as obesity, atherosclerosis, loose skin, and emaciation, which require active cooperation with doctors for treatment. Blood tests and biochemical indicators can reflect the pathological state of the body, especially the levels of peripheral blood cell counts and lipid metabolism-related indicators, which can assist in clinical diagnosis. Peripheral blood cell counts can provide a direct reflection of the patient's peripheral blood cell state and many other conditions within the body, which is very important for the diagnosis and treatment of the disease. Some studies have shown that SCZ patients have dyslipidemia and high expression of C-reactive protein, suggesting that

blood lipid metabolism is related to the disease to some extent [4].

In clinical practice, many diseases can cause monocyte hyperplasia, such as monocytic dysplasia of bone marrow and infectious mononucleosis. In pathological factors, the peripheral blood monocyte (MON) level increases significantly [5]. MON and macrophages can mediate inflammatory responses by altering cytokines related to inflammatory responses, and promote the occurrence and progression of atherosclerosis [6]. Studies have found that HDL regulated the flow of cholesterol in macrophages and inhibited the expression of pro-inflammatory factors in MON to exert anti-inflammatory effects [7]. Therefore, analyzing the relationship between MON and blood lipid metabolism indicators such as HDL, has certain clinical significance, and can be regarded as an indirect marker of inflammatory response. Currently, there are no widely used serum indicators for the diagnosis of CSCZ patients [8-9], and there is no research on the relationship between peripheral whole blood cell count levels and dyslipidemia in CSCZ patients. This study compares the peripheral whole blood cell counts, MON level, and blood lipid indicators of CSCZ patients and healthy controls, which to discuss the indicators differences in CSCZ patients. Then exploring the relationship between abnormal blood lipid metabolism and peripheral blood monocyte level, providing a certain scientific theoretical basis for the clinical diagnosis and treatment of CSCZ patients.

## 2. Materials and Methods

### 2.1. Participants

This study was conducted at Xiamen Xianyue Hospital from January to December 2023, and 150 long-term hospitalized CSCZ patients were selected as case group, including 71 males and 79 females, as well as 100 healthy individuals who underwent health examination during the same period (including 48 males and 52 females) as healthy controls. The inclusion criteria for CSCZ patients were as follows: ①They met the diagnostic criteria for schizophrenia as stipulated in the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5). ②They were aged 20-85 years old and Han ethnic group. ③They had a history of schizophrenia diagnosis for at least 5 years. ④They had been taking oral antipsychotic drugs at a stable dose for at least 12 months before enrollment. The exclusion criteria were as follows: ①They met the diagnostic criteria for mental retardation as stipulated in DSM-5. ②Patients with other mental disorders such as anxiety disorder, depressive disorder, and bipolar disorder; ③Patients with serious and potentially interfering physical diseases or other mental, neurological, cardiovascular, hematological, and immune system diseases. ④Patients who had taken nonsteroidal anti-inflammatory drugs within the past 10 days. ⑤Patients who had fever or allergic reactions within the past 2 weeks that could affect their immune function. ⑥Pregnant or lactating women. This study complied with the Helsinki Declaration and was approved by the Ethics Committee of Xiamen Xianyue Hospital (approval number: 2023-KY-023, 2024-KY-044), and informed consent was obtained from the participants.

### 2.2. Measurement of Peripheral Complete Blood Cell Count Levels

5 mL peripheral venous blood sample was collected from the subjects in a fasting state. The serum was isolated through centrifugation at 3000 rpm for 15 minutes. The peripheral complete blood cell count levels, including white blood cell count (WBC), neutrophil percentage (NEU%), neutrophil count (NEU#), lymphocyte percentage (LYM%), lymphocyte count (LYM#), neutrophil-to-lymphocyte ratio (NLR), red blood cell count (RBC), hemoglobin concentration (HGB), platelet count (PLT), platelet distribution width (PDW), mean platelet volume (MPV), platelet volume percentage (PCT), monocyte count (MON#), and monocyte percentage (MON%), were assessed using an automated hematology analyzer (Sysmex-XN1000, Japan), along with the appropriate reagents.

### 2.3. Determination of Blood Lipid Metabolism Indicators

5 mL of venous blood was collected from the research subjects, and serum was separated from the blood and divided into centrifuge tubes. The lipid indicators including total cholesterol (CHO), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) were determined using an automatic biochemistry analyzer (Hitachi 008AS, Japan).

## 2.4. Criteria for Dyslipidaemia

According to the definition in the "Chinese Lipid Management Guidelines (2023)" [10], CHO  $\geq$  6.2 mmol/L is hypercholesterolemia, TG  $\geq$  2.3 mmol/L is hypertriglyceridemia, HDL-C  $<$  1.0 mmol/L was defined as low HDL-C, and LDL-C  $\geq$  4.1 mmol/L was defined as high LDL-C. If any one of the four indicators is abnormal, it can be determined as a phenomenon of blood lipid metabolism abnormality.

## 2.5. Statistical Analysis

Statistical analysis was conducted using GraphPad Prism 8.0.1 and SPSS 24.0 software. The measurement data were assessed for homogeneity of variance and normality using appropriate tests. Normal distribution was presented as mean  $\pm$  standard deviation (SD), and comparisons were made using t-tests. Non-normal distribution was expressed as [M ( $P_{25}$ ,  $P_{75}$ )] and analyzed using the Mann-Whitney U test. Count data were presented as [n (%)] and compared using the  $\chi^2$  test. Univariate and multivariate binary logistic regression analyses were performed on statistically significant indicators selected based on their significance level of  $P < 0.05$  for identifying associations with the outcome variable(s). Linear regression correlation analysis was conducted using Hplot Por mapping.

## 3. Results

### 3.1. Demographic Characteristics

The study included a total of 150 patients with CSCZ, comprising 71 males and 79 females, with an average age of  $55.50 \pm 12.27$  years. In the healthy control group, there were 48 males and 52 females, with an average age of  $54.34 \pm 8.57$  years. No significant differences were observed in terms of gender distribution and age composition between the two groups ( $P > 0.05$ ) (see Table 1).

Table 1: The age and gender demographics of the two groups were compared.

Characteristics		CSCZ group (n=150)	Healthy control group(n=100)	t/ $\chi^2$	P
Age (years)		55.50 $\pm$ 12.27	54.34 $\pm$ 8.57	0.879	0.380
Gender <sup>a</sup> (n, %)	Male	71(59.7%)	48(40.3%)	0.011	0.918
	Female	79(60.3%)	52(39.7%)		
Time of disorder progression (years)		25.25 $\pm$ 12.79	-	-	-

Notes: <sup>a</sup>Chi-squared test. Others for Student t-test, data are presented as mean  $\pm$  SD.

### 3.2. Comparison of Complete Blood Cell Count Levels between CSCZ and Healthy Controls

Table 2: The peripheral complete blood cell count levels of two groups were compared.

Indexes	CSCZ group (n=150)	Healthy control group (n=100)	t/Z	P
WBC ( $10^9/L$ )	6.6646 $\pm$ 2.171	6.0669 $\pm$ 1.570	2.518	0.012
NEU (%)	56.710 $\pm$ 10.406	56.002 $\pm$ 8.039	0.604	0.546
NEU# ( $10^9/L$ )	3.500 (2.690, 4.627)	3.200 (2.710, 3.960)	-1.445	0.149
LYM (%)	32.254 $\pm$ 9.7305	34.702 $\pm$ 7.8006	-2.193	0.029
LYM# ( $10^9/L$ )	2.0603 $\pm$ 0.7211	2.0570 $\pm$ 0.5280	0.042	0.967
RBC ( $10^{12}/L$ )	4.2607 $\pm$ 0.5437	4.6918 $\pm$ 0.6391	-5.706	<0.001
HCT (%)	38.516 $\pm$ 3.997	41.308 $\pm$ 4.289	-5.238	<0.001
MCV (fl)	91.350 (88.475, 94.525)	90.200 (87.000, 92.900)	-2.295	0.022
RDW-CV (%)	13.100 (12.600, 13.025)	12.600 (12.200, 13.300)	2.591	0.010
RDW-SD (fl)	43.763 $\pm$ 3.9399	42.183 $\pm$ 5.6781	2.591	0.010
HGB (g/L)	127.12 $\pm$ 13.817	137.596 $\pm$ 16.750	-5.169	<0.001
PLT ( $10^9/L$ )	243.34 $\pm$ 65.229	230.727 $\pm$ 57.530	5.044	<0.001
PDW (fl)	10.650 (9.675, 12.100)	10.00 (8.725, 10.900)	-3.901	<0.001
MPV (fl)	10.013 $\pm$ 0.9399	9.411 $\pm$ 0.7355	5.607	<0.001
PCT (%)	0.240 (0.200, 0.272)	0.2150(0.190, 0.240)	-3.225	0.001
MON# ( $10^9/L$ )	0.480 (0.380, 0.612)	0.370 (0.300, 0.480)	-4.840	<0.001
MON (%)	7.650 (6.300, 9.300)	6.400 (5.200, 7.600)	-5.100	<0.001

There were significant differences in 14 indicators ( $P < 0.05$ ), including white blood cell count

(WBC), lymphocyte percentage (LYM%), red blood cell count (RBC), hematocrit (HCT), mean corpuscular volume (MCV), red blood cell distribution width standard deviation (RDW-SD), red blood cell distribution width percentage (RDW-CV), hemoglobin concentration (HGB), platelet count (PLT), platelet distribution width (PDW), platelet average volume (MPV), platelet volume percentage (PCT), monocyte count (MON#), and monocyte percentage (MON%) between CSCZ patients and healthy controls (see Table 2). Among them, LYM%, RBC, HCT, and HGB were significantly lower in the CSCZ group compared to the healthy control group, whereas WBC, MCV, RDW-SD, RDW-CV, PLT, PDW, MPV, PCT, MON#, and MON% levels were significantly elevated in the CSCZ group relative to healthy control group. There was no significant difference in neutrophil percentage (NEU%), neutrophil count (NEU#) or lymphocyte count (LYM#) between the two groups ( $P > 0.05$ ).

### 3.3. Analysis of Blood Lipid Metabolism Indicators Levels and Dyslipidaemia in CSCZ Patients

The levels of HDL-C, LDL-C and CHO in the CSCZ group were lower than those in healthy control group significantly ( $P < 0.05$ ). The TG level of CSCZ group was lower than that of control group, but the difference was not statistically significant ( $P > 0.05$ ) (see Table 3). The rate of dyslipidemia was 32% (48/150) in the CSCZ group and 33% (33/100) in healthy control group ( $P > 0.05$ ).

Table 3: Analysis of blood lipid indicators levels in the two groups.

Indexes (mmol/L)	CSCZ group (n=150)	Healthy control group (n=100)	t/Z	P
HDL-C	1.292±0.361	1.416±0.285	-3.021	0.003
LDL-C	2.986±0.760	3.427±0.853	-4.271	<0.001
CHO	4.678±0.919	5.388±1.077	-5.586	<0.001
TG	1.035 (0.797, 1.477)	1.055 (0.822, 1.497)	-0.449	0.653

### 3.4. Logistic Regression Analysis of the Influencing Factors of Dyslipidaemia in CSCZ Patients

The results of whether CSCZ patients had dyslipidemia were taken as the dependent variable, with gender, age, and 14 hematological parameters selected from the significant changes identified in the previous analysis as independent variables, and were entered into a binary logistic regression model for univariate and multivariate analysis. The analysis showed that gender, HCT, HGB, MON#, and RBC were significantly associated with the risk of CSCZ patients having dyslipidemia (OR = 2.180, 1.215, 1.060, 5.467, 3.073,  $P < 0.05$ ) (see Table 4). Furthermore, the multivariate analysis was conducted on gender, HCT, HGB, MON#, and RBC, which showed that MON# was associated with the occurrence of dyslipidemia in CSCZ patients significantly, and it may be the factors that promote dyslipidemia (OR = 6.216,  $P = 0.027$ ).

Table 4: Logistic analysis of the influencing factors for CSCZ with dyslipidemia.

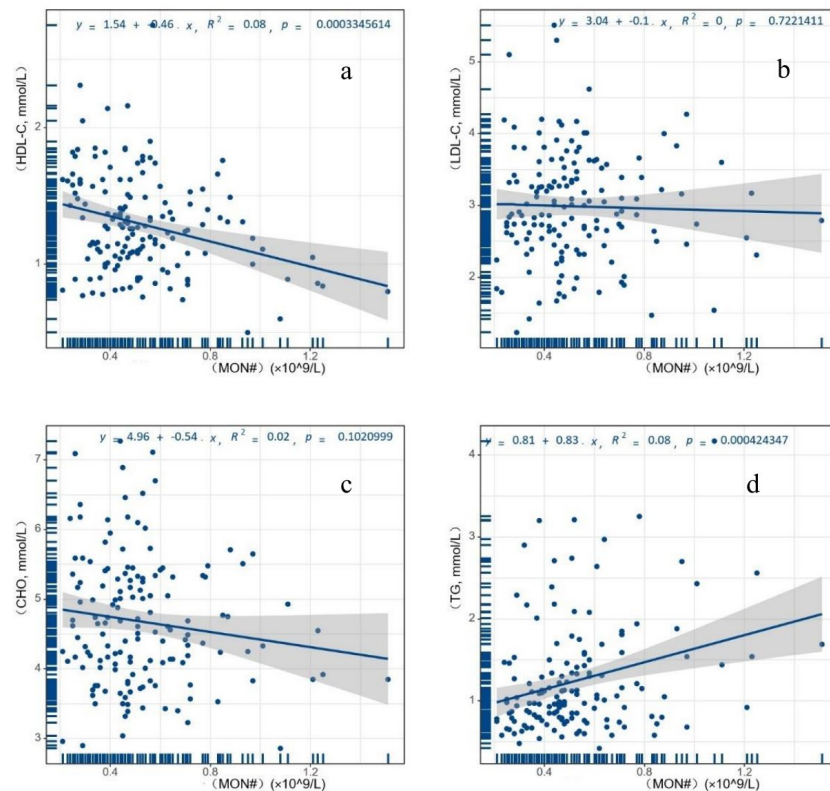
Indexes	Univariate analysis			Multivariate analysis		
	P	OR	95% CI	P	OR	95% CI
Gender	0.029	2.180	1.083-4.391	0.924	1.002	0.971-1.034
Age	0.539	0.991	0.964-1.019	-	-	-
WBC	0.111	1.136	0.971-1.329	-	-	-
NEU%	0.657	0.992	0.960-1.026	-	-	-
NEU#	0.349	1.091	0.910-1.307	-	-	-
LYM%	0.796	1.005	0.970-1.041	-	-	-
LYM#	0.096	1.507	0.931-2.440	-	-	-
RBC	0.002	3.073	1.505-6.276	0.690	1.267	0.396-4.053
HCT	<0.001	1.215	1.094-1.350	0.836	0.956	0.627-1.460
MCV	0.618	0.987	0.937-1.040	-	-	-
RDW-CV	0.974	0.995	0.730-1.357	-	-	-
RDW-SD	0.850	0.989	0.905-1.080	-	-	-
HGB	<0.001	1.060	1.028-1.093	0.251	1.067	0.955-1.193
PLT	0.340	0.997	0.992-1.003	-	-	-
PDW	0.116	1.136	0.969-1.331	-	-	-
MPV	0.191	1.257	0.886-1.833	-	-	-
PCT	0.696	0.302	0.001-122.007	-	-	-
MON#	0.028	5.467	1.200-24.913	0.027	6.216	1.235-31.284
MON%	0.239	1.092	0.943-1.264	-	-	-

Notes: Odds Ratio (OR) > 1, suggesting that exposure factors are promoting factors for the occurrence

of positive events, that is, promoting the occurrence of dyslipidemia;  $OR < 1$ , indicating that the exposure factor is a hindering factor for the occurrence of positive events, that is, hindering the occurrence of dyslipidemia. 95% CI: 95% upper and lower confidence intervals.

### 3.5. Correlation Analysis between MON and Blood Lipid Indicators Levels

The correlation between MON and HDL-C, LDL-C, CHO and TG levels was further analyzed by linear regression scatter plot respectively, to explore the correlation between MON and blood lipid indicators (see Figure 1). The results showed that there was the negative correlation between MON and HDL-C and the positive correlation between MON and TG significantly ( $P < 0.05$ ), but no significant correlation between MON and LDL-C or CHO in CSCZ patients.



(a: HDL-C. b: LDL-C. c: CHO. d: TG.  $P < 0.05$  was considered statistically significant.  $-1 < R^2 < 1$ , means that the closer  $R^2$  is to 1 or -1, the better the fit.)

Figure 1: Scatter plot of linear regression analysis of Monocyte level MON and lipid Index levels.

## 4. Discussion

The findings of this study indicated significant differences in 14 peripheral blood cell count parameters between CSCZ patients and healthy controls. Specifically, the levels of HDL-C, LDL-C, and CHO were found to be lower in CSCZ group compared to the healthy group. Logistic regression analysis revealed that HCT, HGB, MON#, and RBC were associated with the risk of concurrent dyslipidemia. Notably, the elevated MON# level was significantly correlated with abnormal lipid metabolism. Furthermore, MON exhibited a negative correlation with HDL-C and a positive correlation with TG.

Previous studies reported that abnormal levels of TC, TG, LDL-C, and HDL-C were closely linked to the onset of schizophrenia [11]. The use of antipsychotic medications is unavoidable in treating schizophrenia patients, these drugs represent a major risk factor for developing metabolic syndrome in SCZ individuals, particularly second-generation antipsychotics, which can adversely affect glucose and lipid metabolism [12]. In this study, both the CSCZ group and control group had an average age exceeding 50 years old, categorizing them as elderly populations. Analysis results indicated differences in three blood lipid indicators: CHO, HDL-C, and LDL-C, with values being lower in the CSCZ group. Among 14 routine blood indicators showing significant differences, HCT, HGB, LYM%, RBC were higher in

the control group than those observed in the CSCZ group. Conversely, nine other indicators were greater within the CSCZ cohort compared to controls. The observation that WBC counts were higher among cases while RBC counts exceeded those seen in controls aligns with multiple reports<sup>[13-14]</sup>, also findings related to HGB, LYM%, RDW%, MON# corroborate existing literature<sup>[15]</sup>.

This study found that the presence of dyslipidemia in SCZ patients was significantly associated with MON# through binary logistic regression of univariate and multivariate analysis. Peripheral blood mononuclear cells (PBMCs), which mainly consist of lymphocytes and monocytes, have the potential to be biomarkers for predicting clinical outcomes and metabolic side effects of SCZ<sup>[16]</sup>. MON# is an indicator of monocyte concentration, and abnormal monocyte absolute value indicates the presence of inflammation, infection, infectious diseases in the body. The relationship between MON# and dyslipidemia is consistent with the conclusion of Huang Junjie et al.<sup>[16]</sup>, suggesting that monocyte-related indicators may become biomarkers for predicting the clinical outcomes and metabolic side effects of CSCZ. MON mature and are released into the bloodstream, where they remain in the blood for 3-6 days before entering tissues or body cavities and developing into macrophages. MON and macrophages constitute the mononuclear-phagocyte system and play a defensive role, but no study reported their association with the onset of CSCZ. MON not only mediate inflammatory responses, causing endothelial cell damage, but also induce the expression of circulating inflammatory factors, thereby activating platelets and triggering thrombosis<sup>[17-18]</sup>. HDL is an important anti-atherosclerotic lipoprotein component, and some studies have found that HDL inhibited the activation of CD11 in MON to play a role in anti-inflammatory responses<sup>[19]</sup>.

Dyslipidemia is associated with cardiovascular disease, and in recent years, studies shown that as the number of cardiovascular disease risk factors increases, white blood cell counts, neutrophil count, and MON count all increase continuously. White blood cell count, especially MON count, is closely related to the risk factors of cardiovascular disease<sup>[20]</sup>. The expression of triglyceride hydrolase (ATGL) mRNA in peripheral blood mononuclear cells was increased in patients with metabolic syndrome<sup>[21]</sup>. Age, triglyceride level and insulin resistance index increasing are the comprehensive independent risk factors for increased ATGL mRNA expression. The positive rate of TLR4 in MON of patients with metabolic syndrome is higher, indicating that MON may be involved in the occurrence and development of metabolic syndrome in CSCZ patients<sup>[22]</sup>. It was investigated the expression of apolipoprotein E (ApoE) gene in peripheral blood MON and its correlation with hypertension and blood lipids, which was found that the expression level of ApoE in peripheral blood MON of high-risk and extremely high-risk hypertensive patients was significantly down-regulated and associated with dyslipidemia<sup>[23]</sup>. Therefore, the monitoring of peripheral blood MON count is of great significance for the treatment and prognosis of CSCZ.

However, the limited sample size of our study may compromise the representativeness of its findings. Additionally, this research has not delved into the underlying mechanisms. Thus, further comprehensive studies are warranted to validate these results. Given that CSCZ is a multifaceted disorder, reliance on single diagnostic indicators proves less reliable for patient evaluation. A holistic approach incorporating multiple objective metrics can enhance both diagnostic sensitivity and predictive accuracy.

## 5. Conclusions

In conclusion, significant differences exist in peripheral blood cell counts levels and blood lipid metabolism between patients with CSCZ and healthy controls. HCT, HGB, MON, and RBC may play a crucial role in the pathogenesis of CSCZ, while MON cell levels may be associated with dyslipidemia observed in these patients. The assessment of these parameters holds substantial auxiliary diagnostic value for CSCZ.

## Acknowledgements

This work was supported by project grants from the Xiamen Medical and Health Guidance Project (Grant No. 3502Z20244ZD1305, 3502Z20224ZD1321), Xiamen Natural Science Foundation joint project (Grant No. 3502Z20227416), and Xiamen Xianyue Hospital Scientific Research Project (Grant No. 2023-XYB01, 2023-XYZD02). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

**References**

- [1] Weye N, Santomauro D F, Agerbo E, et al. Register-based metrics of years lived with disability associated with mental and substance use disorders: a register-based cohort study in Denmark[J]. *Lancet Psychiatry*, 2021, 8(4): 310-319.
- [2] Ding Shuyan, Li Xuefang, Zhu Yafang, Zhao Ping, You Zhijun. The effect of case-management community intervention on patients with schizophrenia from a two-factor perspective[J]. *Jiangsu Journal of Preventive Medicine*, 2020, 31(5): 508-510,515.
- [3] Sun Jing, Zhang Zhijun, Wang Congjie, et al. To study the association between plasma fasting free fatty acids and fasting plasma glucose in patients treated with psychotics for a long period of time[J]. *Journal of Clinical Psychiatry*, 2004(5): 259-261.
- [4] Tao Huai, Chen Fang, Luo Hong, et al. The levels of complement component 3, complement component 4, high sensitivity C reactive protein, and uric acid in serum of schizophrenia[J]. *Chinese Journal of Nervous and Mental Diseases*, 2017, 43(9): 544-548.
- [5] Yuan Xiangping, Li Jiang. Influencing factors analysis of the increase of blood mononuclear cell count [J]. *Journal of Human University of Chinese Medicine*, 2017, 37(9): 986-988.
- [6] Uslu A U, Sekin Y, Tarhan G, et al. Evaluation of monocyte to high-density lipoprotein cholesterol ratio in the presence and severity of metabolic syndrome[J]. *Clin Appl Thromb Hemost*, 2018, 24(5): 828-833.
- [7] Solak Y, Yilmaz M I, Siriopol D, et al. Serum neutrophil gelatinase-associated lipocalin is associated with cardiovascular events in patients with chronic kidney disease[J]. *Int Urol Nephrol*, 2015, 47(12): 1993-2001.
- [8] Sun Ying. Clinical study on serum homocysteine level in schizophrenic patients[J]. *Chinese Community Doctors*, 2019, 35(10): 129-130.
- [9] Zhang Zhicheng. Analysis of application value of myocardial enzyme test in patients with schizophrenia [J]. *Systems Medicine*, 2019, 4(9): 42-43.
- [10] Chinese Lipid Management Guidelines Revision Joint Expert Committee. Chinese Lipid Management Guidelines (2023)[J]. *Chinese Journal of Cardiology*, 2023, 51(3): 221-255.
- [11] He Yong, Zhang Xiaochun, Fang Min, et al. Correlation study between violent risk and blood lipid levels in vagrant schizophrenia patients in Guangzhou[J]. *China Modern Medicine*, 2019, 26(15): 97-99.
- [12] Liao Xuemei, Ye Hui, Si Tianmei. A Review of Switching Strategies for Patients with Schizophrenia Comorbid with Metabolic Syndrome or Metabolic Abnormalities[J]. *Neuropsychiatr Dis Treat*, 2021, 17: 453-469.
- [13] Guo Yangyi, Lu Zhengyou, Zhang Lin, et al. Correlation analysis of peripheral complete blood cell counts in patients with schizophrenia and depression [J]. *China Health Standard Management*, 2023, 14(3): 96-99.
- [14] Ma Qingyan, Zhou Lina, Fan Yajuan, et al. Study on the level of peripheral blood cell count and its correlation with clinical symptoms in patients with schizophrenia[J]. *Clinical Research and Practice*, 2019, 4(22): 5-7.
- [15] Wu Qijin, Hou Lingzhi, Cheng Jun, et al. Total leukocyte count and classification in first-episode drug-naive patients with schizophrenia[J]. *Journal of International Psychiatry*, 2022, 49(1): 38-40.
- [16] Huang Junjie, Wang Huiling. The role of peripheral blood mononuclear cells in schizophrenia[J]. *Neural Injury and Functional Reconstruction*, 2023, 18(4): 220-222.
- [17] Chistiakov D A, Grechko A V, Myasoedova V A, et al. The role of monocytosis and neutrophilia in atherosclerosis [J]. *J Cell Mol Med*, 2018, 22(3): 1366-1382.
- [18] Arisoy A, Altunkasf, Karaman K, et al. Association of the monocyte to HDL cholesterol ratio with thrombus burden in patients with ST-segment elevation myocardial infarction[J]. *Clin Appl Thromb Hemost*, 2017, 23(8): 992-997.
- [19] Canpolat U, Cetin EH, Cetin S, et al. Association of monocyte-to-HDL cholesterol ratio with slow coronary flow is linked to systemic inflammation[J]. *Clin Appl Thromb Hemost*, 2016, 22(5): 476-482.
- [20] Yang Chao, Cui Wei, Liu Fan, et al. The relationship between cardiovascular disease risk factors and white blood cell count[J]. *Journal of Hebei Medical University*, 2009, 30(5): 156-161.
- [21] Jin Chengwei, Li Kui, Zhao Jing, et al. Relationship between the mRNA expression of adipose triglyceride lipase in peripheral blood mononuclear cells and metabolic syndrome[D]. *Journal of Shandong University (Health Sciences)*, 2014, 52 (08): 39-42
- [22] Li Xiaohui, Sha Ting, Peng Cheng, et al. Change of toll like receptor 4 expression in blood mononuclear cells of patients with metabolic syndrome[J]. *Chinese Journal of Arteriosclerosis*, 2016, 24(3): 273-275.
- [23] Li Jianzhong, Zhao Jun, Guo Guangqing, et al. Apolipoprotein E gene expression in peripheral blood monocyte and lipid analysis of hypertension patients[J]. *Journal of Shandong University (Health Sciences)*, 2009, 47(02): 50-52+57.