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Epidemiological and clinical characteristics of dengue fever in Fuzhou, China, in 2023

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Abstract

Background This study aimed to analyze the epidemiological and clinical characteristics of dengue fever (DF) in Fuzhou, the capital city of Fujian Province, southeast China.

Methods A retrospective analysis was performed on 251 cases of DF diagnosed at the fever clinic of the Second Affiliated Hospital of Fujian University of Chinese Medicine in Fuzhou City, Fujian Province. Epidemic characteristics, such as the number of cases, age distribution, sex distribution, seasonal distribution, and spatial distribution in each region, were analyzed. The patients' clinical manifestations, signs, auxiliary examinations, and prognoses were analyzed.

Results The age distribution of DF cases was mainly concentrated in 30–39 years (20.72%) and 50–59 years (21.12%). There were no sex differences among the patients. Of these cases, 60.16% were concentrated on the lower floors, with retirees having the highest proportion. The seasonal peak of DF in Fuzhou area was from September to November. The SDE plot showed that the cases were mainly concentrated in Jin'an and Gulou districts. Etiological tests revealed serum NS1 antigen (97.61%), serum IgM antibody (15.14%), and serum IgG antibody (0.40%). There were no significant differences in clinical manifestations between the children's and non-children's groups. Laboratory tests have shown that the disease is prone to multi-system dysfunction, including the blood system, digestive system, urinary system and internal environment. ROC curve analysis showed that WBC, N, LY, PLT, and CRP levels had specific diagnostic values for DF.

Conclusions The epidemiological situation and clinical characteristics of DF in Fuzhou City were analyzed to guide the formulation of reasonable prevention and treatment measures.

Keywords Dengue fever, Clinical characteristics, Epidemiology, Public health

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Dengue fever (DF) is an acute infectious disease caused by dengue virus. DF, one of the most widespread Mosquito-borne diseases in the world, is transmitted by Aedes mosquitoes. It is an acute infectious disease caused by four dengue virus serotypes, mainly transmitted by Aedes aegypti and Aedes albopictus [1]. It is widely distributed throughout Southeast Asia, South America, and Africa. In China, DF is prevalent in Guangdong, Guangxi, Hainan, Fujian, Yunnan, Zhejiang, and other southern regions, and the epidemic season is mainly from June to October [2]. Among them, Fujian Province, located in the southeast sea, has been dominated by imported cases, there were outbreaks of local infections in 1999, 2004, 2007, 2008, and 2016. The high-risk period of DF is from June to October, which may be related to climatic conditions [3]. Field investigations of local cases showed that there were many mosquito breeding sites and a high density of mosquito vectors, which became potential risk factor for DF outbreaks [4].

Fuzhou is the provincial capital city and largest city in Fujian Province. In 2023, several local cases were reported in this region. The subtropical monsoon climate in Fuzhou, with suitable temperatures and abundant rainfall, is suitable for mosquito breeding and reproduction [5]. There have been no large-scale clinical reports on DF in this region. Therefore, we conducted a retrospective clinical study of DF in a large tertiary general hospital in Fuzhou, the capital city of the Fujian Province, China. A total of 251 DF cases detected at the Second Affiliated Hospital of Fujian University of Chinese Medicine in 2023 were included in this study. A detailed understanding of the epidemiological and clinical characteristics of DF in Fuzhou City is required to develop more effective public health strategies for the occurrence of the disease.

Methods

Data collection

This project is completed by Department of Infectious Diseases of the Second Affiliated Hospital of Fujian University of Traditional Chinese Medicine (Also called "The Second People's Hospital of Fujian Province"). The clinical data of 251 patients were obtained from the outpatient medical record system of the hospital. The hospital is a large, comprehensive, tertiary hospital in Fuzhou, in which the fever clinic (affiliated with the Department of Infectious Diseases) is the central department for DF diagnosis, treatment, and screening. National monthly DF reporting data comes from the column "Notifiable Infectious Disease Report" (https://www.ndcpa.gov.cn/jbkzzx/c100016/common/list.html) on the official website of the Chinese Center for Disease Control and Prevention. This study systematically reviewed the epidemiological and clinical characteristics of patients with dengue in Fuzhou, the capital city of Fujian Province, including sex, age, occupation, clinical signs and symptoms, ancillary examinations, and prognosis. A total of 251 dengue cases were included, including 124 males and 127 females, in the age range of (4–86) years, and all had an epidemiological history of mosquito bites. The treatment duration was mainly 2–7 days, with an average of 5–7 days and a maximum of 21 days.

Diagnostic criteria

Dengue cases were defined according to the 2009 World Health Organization guidelines and the Chinese national criteria for dengue diagnosis (WS216-2018), which included suspected and confirmed cases. The suspected dengue cases met the following criteria: (1) Epidemiological history (travel to a dengue-endemic area within 14 days before the onset of illness, or the presence of a dengue case in the vicinity of the place of residence within 1 month); (2) The clinical manifestations include sudden high fever, rash, obvious fatigue, anorexia, nausea, often accompanied by headache, orbital pain, body soreness, skin flushing, etc. (3) Routine blood tests revealed thrombocytopenia and/or leukopenia. For laboratory diagnosis, the patients were required to meet one of the following criteria: (1) A 4-fold or more increase or seroconversion of dengue virus-specific IgG antibody in serum during the convalescent phase compared with the acute phase; and (2) Dengue virus was isolated from the patient's blood, cerebrospinal fluid, or tissue during the acute phase, and (3) Detection of dengue virus nucleic acids using real-time fluorescent quantitative RT-PCR [6]. If the dengue NS1 antigen is positive, combined with the clinical symptoms and epidemiological history, a clinically confirmed case can be considered.

Laboratory indicators

In this project, data from DF patients were collected for blood routine, urine routine, liver function, renal function, serum electrolytes, C-reactive protein (CRP), dengue IgG/IgM antibody, dengue NS1 antigen test, and other laboratory indicators. Among them, 43 patients underwent serum electrolyte tests, 34 underwent liver function tests, 26 underwent renal function tests, and 12 underwent routine urine tests.

ROC curve analysis

Dengue fever patients were admitted to the hospital due to fever, which needs to be distinguished from other febrile diseases. Routine blood tests and CRP are the most convenient and inexpensive laboratory tests in fever clinics and have great clinical value. Therefore, the receiver operating characteristic (ROC) curve was used to analyze the diagnostic value of WBC, N, LY, PLT, and CRP for DF. Clinical data from 210 non-dengue-infected patients who visited the fever clinic during the same period were included in this study. A total of 210 patients with non-dengue fever were used as the control group. Taking the clinical diagnosis of "dengue fever" as the gold standard, the ROC curve was drawn, and the area of ROC curve of these indicators was compared to evaluate its sensitivity and specificity in the prediction of dengue fever patients. Finally, the ROC curve was used to analyze the diagnostic value of WBC, N, LY, PLT and CRP for DF.

Statistical analysis

This study analyzed clinical and laboratory-confirmed DF cases at the Second People's Hospital of Fujian Province in 2023. In China, DF is classified as a Class B notifiable infectious disease. All cases of DF must be reported to the Chinese Centers for Disease Control and Prevention. We obtained population data from the Fujian Provincial Bureau of Statistics to calculate incidence rates. According to the seventh national census, there were 8,291268 permanent residents of Fuzhou (https://tjj.fujian.gov.cn/xxgk/tjgb/202105/t20210520_5598804.htm). GraphPadPrism (version 8.0) was used for statistical analysis and graph generation. Topographic and standard deviation ellipse (SDE) mapping were performed using ArcGIS (version 10.8.2). The SDE was drawn to understand the direction and range of the distribution of the cases in Fuzhou. The primary and minor half-axes of the ellipse represent the direction and range of data distribution, respectively. The difference between the major and minor half-axis was more significant, indicating that the distribution was more directional. The constituent ratio is used to express the proportion and distribution of each component of the disease in the population, and is generally expressed as a percentage. The chi-square test was used to compare differences between the child and non-child groups. The receiver operating characteristic curve (ROC) was used to analyze the diagnostic values of WBC, N, LY, PLT, and CRP for DF. Statistical significance was set at $P<0.05$.

Results

Demographic characteristics

In the urban area of Fuzhou, the number of dengue patients in Jin'an and Gulou Districts was higher (Fig. 1A). Among 251 patients with DF, 124 (49.40%) were male, and 127 (50.60%) were female. There was no significant difference in the number of patients between males and females (Fig. 1B). Table 1 shows the distribution of DF cases in different age groups, with patients mainly concentrated in 30–39 years (20.72%) and 50–59 years (21.12%). In terms of occupational classification, retirees, cadres, staff, and commercial services accounted for a high proportion, with 37 (14.74%), 36 (14.34%), and 35 (13.94%) cases, respectively. Statistical analysis showed that 60.16% of the dengue patients lived in low-floor houses (Low floor refers to the third floor and below) (Table 1).

Spatial distribution

The extent of the epidemic in each district (county) could be indirectly assessed based on the population proportion and number of patients. There were 132 cases in Jin'an District, accounting for 52.59% of the total cases. There were 90 cases in Gulou District, accounting for 35.86% of the total cases. There were nine cases in Cangshan District, accounting for 3.59%. There were seven cases in the Taijiang District, accounting for 2.79%. There were five cases in the Mawei District, accounting for 1.99%. There were four cases in Minhou County, accounting for 1.59% of the total, which was the lowest in the region (Fig. 2A). Jin'an District is located north of Fuzhou. The primary terrain is hilly, mountainous, dense forest, shrubs, weeds, mountain streams, and rivers all over the upper reaches of the Minjiang River. The surrounding environment of

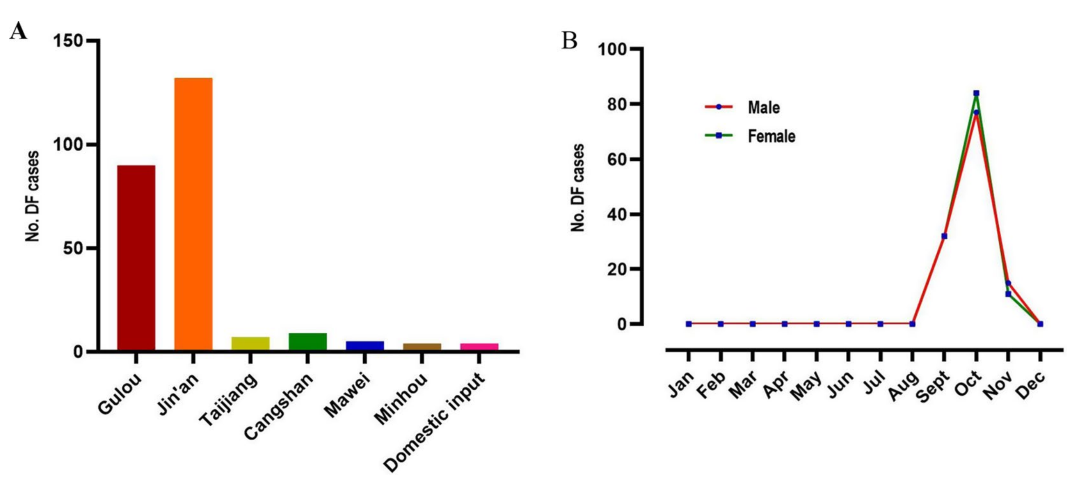

Fig. 1 (**A**) The number of DF cases in urban Fuzhou in 2023; (**B**) Sex distribution of DF cases

Table 1 Demographic characteristics of DF cases(%, *n* = 251)

Variable	*n*	Constituent ratio (%)	Variable	*n*	Constituent ratio (%)
Age groups (y)			High floor > 3	100	39.84%
0~	16	6.37%	Low floor ≤ 3	151	60.16%
10~	8	3.19%	**Occupation**		
15~	10	3.98%	Retiree	37	14.74%
20~	28	11.16%	Cadres and staff	36	14.34%
30~	52	20.72%	Business service	35	13.94%
40~	37	14.74%	Student	32	12.75%
50~	53	21.12%	Worker	24	9.56%
60~	24	9.56%	House worker	17	6.77%
70~	19	7.57%	Restaurateurs	14	5.58%
80~	4	1.59%	Farmer	13	5.18%
Sex			Medical staff	8	3.19%
Male	124	49.40%	Teacher	8	3.19%
Female	127	50.60%	Preschools children	7	2.79%
Living floor			Other	20	7.97%

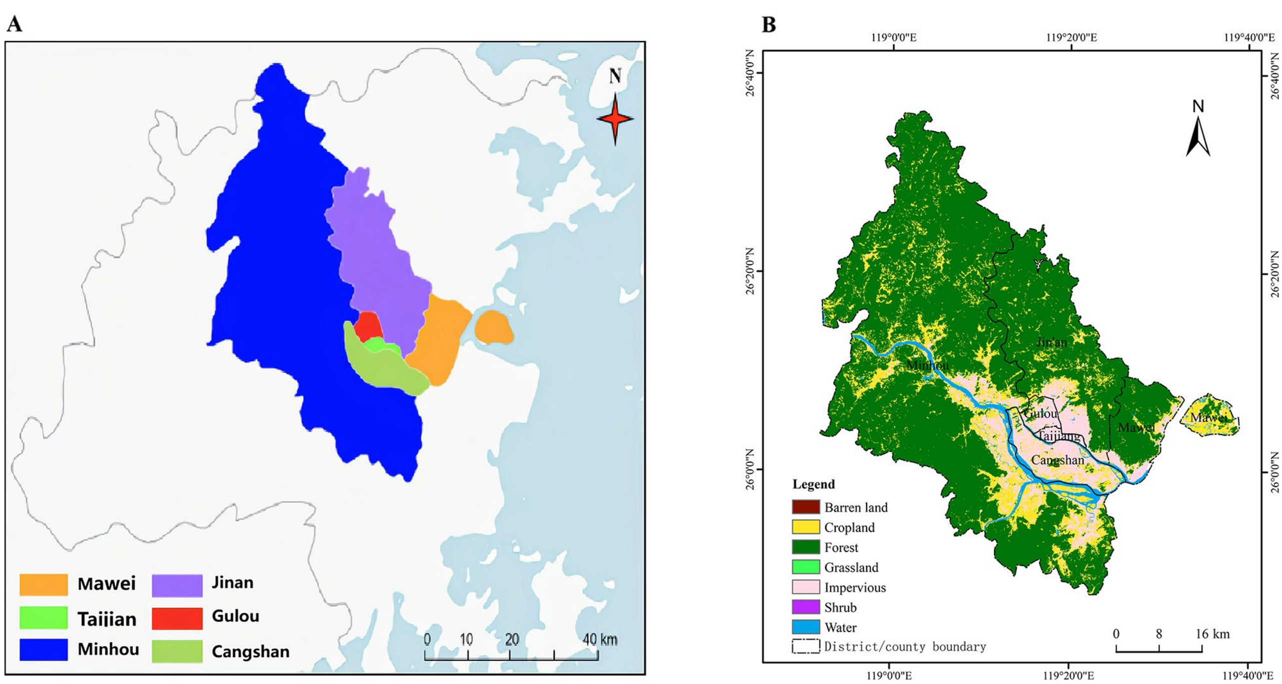

Fig. 2 Spatial distribution and geographical morphology of DF in Fuzhou City, Fujian Province. (**A**) This project used the National Geographic Information Public Service Platform Map Site to create a Fuzhou administrative area map (https://bzdt.fjmap.net/selfmap/web/selfMap/index.html). (**B**) The ecological distribution of urban Fuzhou (https://www.scidb.cn/en/detail?dataSetId=6adb09e7cda942659d9de9ffcf8bb76e)

the area is suitable for mosquito breeding (Fig. 2B). The results of SDE show that the distribution of DF cases in Fuzhou city has a certain direction. This spatial distribution direction indicates that the main cases are distributed in Jin'an and Gulou Districts, and the long half axis of the SDE plot indicates the general direction of the distribution of dengue cases. DF cases in this hospital were mainly from the Jin'an and Gulou districts. In addition, there were four imported cases from other counties in Fujian province (Fig. 3A-D).

Temporal and seasonal distribution

According to data from the National Bureau of Disease Control and Prevention, DF broke out again after the COVID-19 epidemic was lifted, and the number of DF infections in 2023 increased significantly compared to the previous three years. The national dengue epidemic in 2023 has increased significantly from July to November. It showed a downward trend until November, and the heat map showed that September and October were the peaks of incidence (Fig. 4A). The heat map statistics showed that there were incidence peaks of DF in Fuzhou.

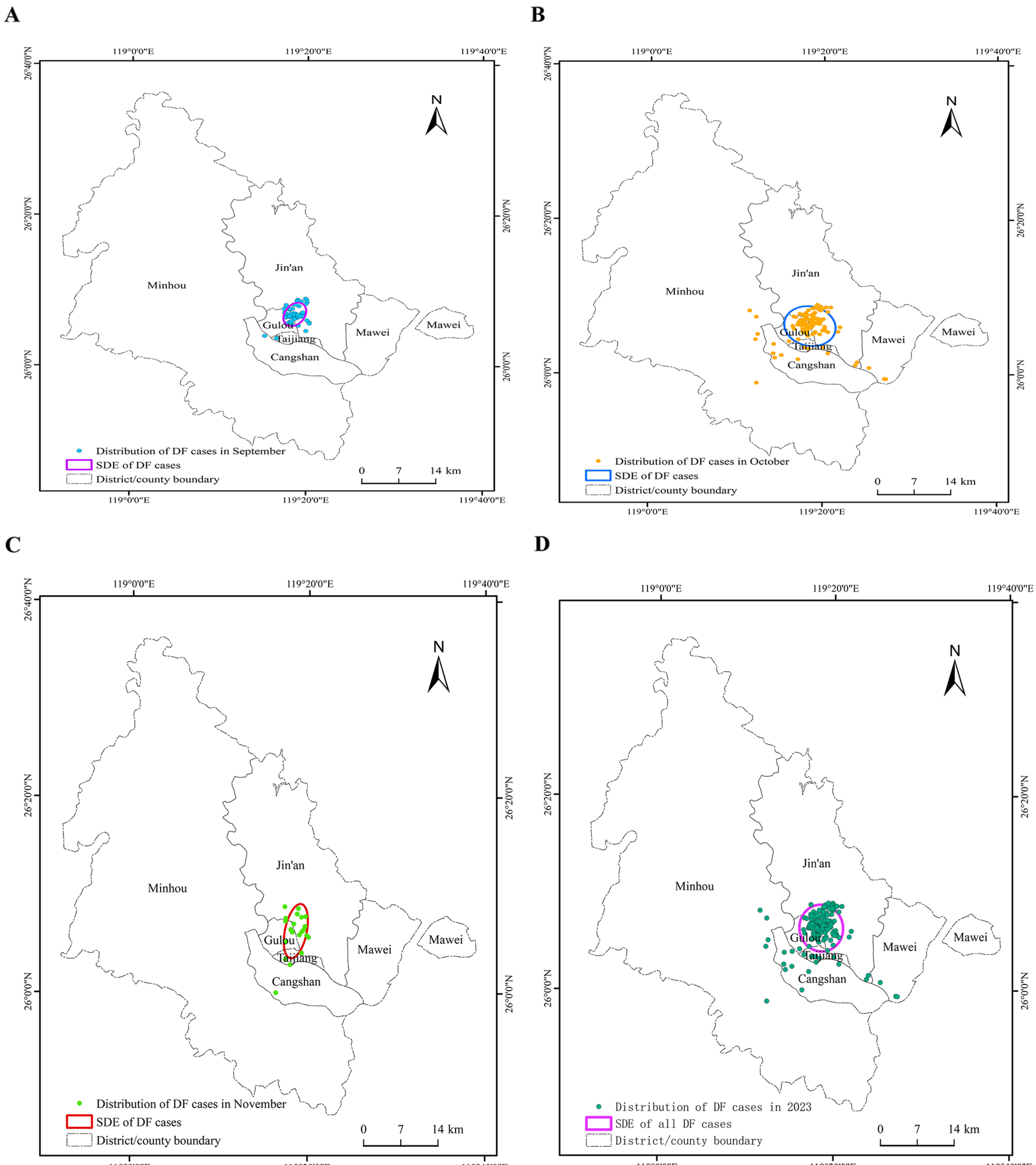

Fig. 3 Standard deviation elliptical plot of the spatial distribution of DF cases from September to November. (**A**) SDE plot of DF cases in September; (**B**) SDE plot of DF cases in October; (**C**) SDE plot of DF cases in November; (**D**) SDE plot of all cases; (**DF**) Dengue fever; (**SDE**) standard deviation ellipse. Based on the longitude and latitude of each patient, ArcGIS 10.8.2 software was used to draw the spatial distribution map. The URL is https://bzdt.fjmap.net/widget/standardmap/result/result.html?resultid=661&yearver=%E5%BD%93%E5%89%8D%E7%89%88%E6%9 C%AC, and you need to add the URL to the ArcGIS to open it

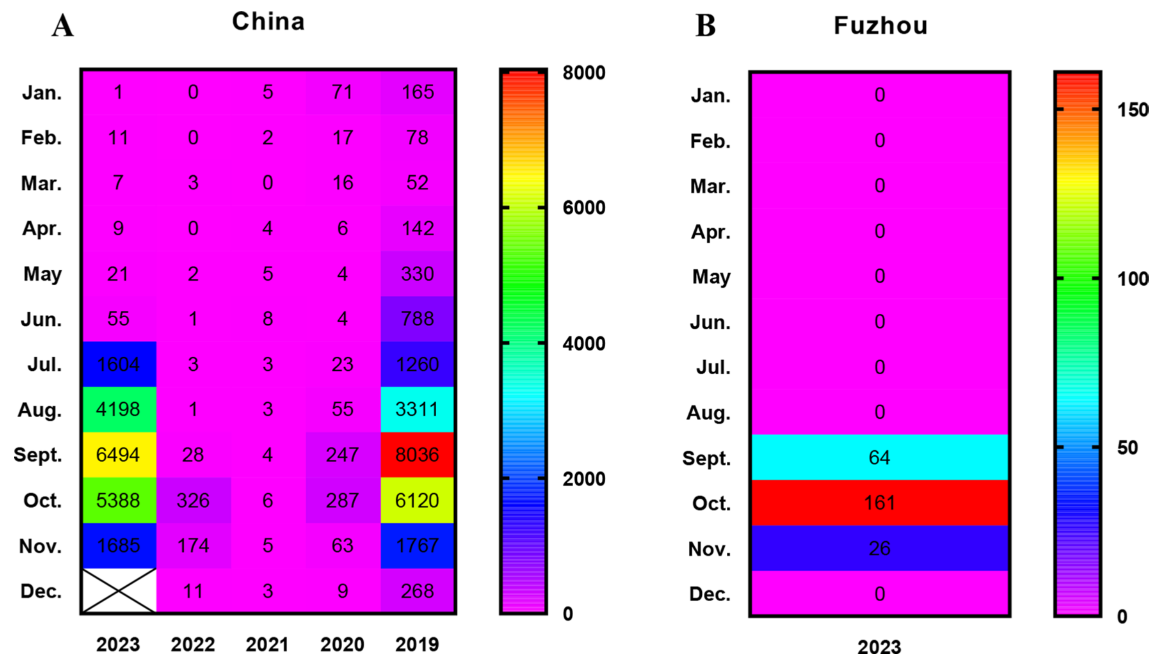

Fig. 4 Monthly distribution of dengue patients in Fuzhou City and all of China. **A**: Monthly incidence of DF in China, 2019–2023. **B** The number of cases of DF in the Second People's Hospital of Fujian Province, Fuzhou, in 2023

Table 2 Comparison of DF pathogen detection results(%, $n=251$)

Pathogen detection	*n*	Children Group ($n=24$)	Non-child Group ($n=227$)	Chi-square	95%CI	*P*
Blood NS1 antigen	245 (97.61%)	21 (87.50%)	224 (98.68%)	11.620	0.021–0.429	0.0007*
Blood IgM antibody	38 (15.14%)	7 (29.17%)	31 (13.66%)	4.064	1.016–6.877	0.0438*
Blood IgG antibody	1 (0.40%)	1 (4.17%)	0 (0%)	9.496	1.051-Infinity	0.0021*

* indicates significance ($P<0.05$)

A prominent epidemic peak occurred from September to November of the year. There were almost no cases from January to July that belonged to this region's static phase of the DF epidemic, indicating that the disease had typical seasonality (Fig. 4B).

Pathogen detection

The etiology test results showed that the positive rate of the diagnostic index of dengue was serum NS1 antigen (97.61%), serum IgM antibody (15.14%), and serum IgG antibody (0.40%). There were significant differences in the positive rates of pathogen detection between the child and the non-child groups ($P<0.05$). The results showed that the positive rate of serum NS1 antigen in the non-children group was higher, while the positive rates of serum IgM and IgG antibodies in the children group were higher than those in the non-children group (Table 2).

Clinical manifestations

The main clinical manifestations of 251 DF cases were fever (100.00%), fatigue (59.76%), muscle soreness (58.57%), and headache (52.19%). All patients attended the fever clinic, and in addition to fever symptoms, more than half had fatigue, muscle soreness, and headache. The main signs were rash (26.29%), lymphadenopathy (12.75%), pulmonary rales (6.37%), and splenomegaly (5.18%) (Table 3). This project also compared the clinical symptoms of the child and the non-child groups, and the results showed that there was no significant difference in clinical symptoms between the two groups ($P>0.05$). None of the children had severe cases, mainly related to the parents' concern for their children's health. All the children received early treatment, and the prognosis was good (Table 4).

Laboratory test results

Before diagnosis, all patients routinely underwent a dengue virus NS1 antigen test, and the submission rate was 100%. The results of blood and urine tests, renal function, liver function, electrolyte, and inflammatory index of 251 patients were analyzed, and the results are shown in Table 5. White blood cell counts are reduced or normal in most patients, with neutrophils and lymphocytes being the predominant blood cells. The eosinophil counts decreased in 74.9% of the patients, whereas the basophils and monocytes were mainly normal. Thrombocytopenia

Table 3 The clinical symptoms and signs of 251 cases of DF(%, $n=251$)

Symptoms	n	%	Signs	n	%
Fever	251	100.00	Rash	66	26.29
Fatigue	150	59.76	Lymphadenectasis	32	12.75
Muscle soreness	147	58.57	Pulmonary rales	16	6.37
Headache	131	52.19	Splenomegaly	13	5.18
Chills	102	40.64	Conjunctival congestion	11	4.38
Lumbago	90	35.86	Hepatic area percussion pain	7	2.79
Orbital pain	51	20.32	Renal area percussion pain	5	1.99
Cough & expectoration	44	17.53	Hepatomegaly	5	1.99
Nausea & vomiting	38	15.14	Bleeding spots	4	1.59
Chest distress	26	10.36	Heart murmurs	4	1.59
Dyspnea	19	7.57	Jaundice	2	0.79
Pruritus	6	2.39	Meningeal irritation sign	1	0.40

and mild anemia were observed in some patients. The renal function of 26 patients was observed, and 15.38% of them had increased creatinine. Liver function was observed in 34 patients with DF. The results showed that 38.24% of the patients had elevated transaminase levels, mainly aspartate transaminase. The electrolyte metabolism disorder is a common manifestation of this disease, which needs to be vigilant, and hyponatremia is the most common. The positive rate of urine protein and occult blood was also relatively high, but the number of cases observed in this study was small. Nearly half of the patients had elevated C-reactive protein levels, and the abnormality rate was 42.63% in this study.

ROC curve analysis

Clinical data of 210 non-dengue-infected patients who visited the fever clinic during the same period were included in this study. The receiver operating characteristic (ROC) curve was used to evaluate the diagnostic value of WBC, N, LY, PLT, and CRP for DF (Table 6). In the prediction of dengue infection and non-dengue infection groups, the area under the ROC curve of WBC was 0.836 (95%CI: 0.799–0.872, $P<0.0001$), the Youden index was 0.549, the cut-off value was 5.765, the sensitivity was 76.1%, and the specificity was 78.9%. The area under the ROC curve of LY was 0.725 (95%CI: 0.678–0.771, $P<0.0001$), Youden index was 0.386, cut-off value was 0.925, sensitivity was 63.3%, and specificity was 75.3%. The AUC of N was 0.811 (95%CI: 0.772–0.850, $P<0.0001$), Youden index was 0.504, cut-off value was 3.395, sensitivity was 86.7%, and specificity was 63.7%. The AUC of PLT was 0.752 (95%CI: 0.708–0.796, $P<0.0001$), Youden index was 0.399, cut-off value was 182.5, sensitivity was 73.4%, and specificity was 66.5%. The area under the ROC curve of CRP was 0.635 (95%CI: 0.585–0.686, $P<0.0001$), Youden index was 0.223, cut-off value was 7.420, sensitivity was 72.9%, and specificity was 49.4% (Fig. 5).

Prognosis and outcome

DF are easily missed or misdiagnosed, and the misdiagnosis rate is high when non-specialist doctors visit. It is easily misdiagnosed as a respiratory infection, epidemic hemorrhagic fever, or fever of unknown origin. Most of the patients can be diagnosed after systematic physical examination, medical history collection and laboratory tests by infectious physicians. Because there is no specific antiviral treatment for the disease, symptomatic treatment such as integrated traditional Chinese and western medicine can be given, and the course of treatment is generally not more than 1 week. In combination with

Table 4 Comparison of clinical manifestations between the two groups(%, $n=251$)

Symptoms	n	Child group($n=24$)	Non-child group($n=227$)	Chi-square	95%CI	P
Fever	251	24 (100%)	227 (100%)	NA	NA	NA
Fatigue	150	12 (50.00%)	138 (60.79%)	1.051	0.2671-1.560	0.3052
Muscle soreness	147	13(54.17%)	134 (59.03%)	0.211	0.3490–1.819	0.6455
Headache	131	12 (50.00%)	119 (52.42%)	0.051	0.3769–2.186	0.8212
Chills	102	12 (50.00%)	90 (39.65%)	0.964	0.6294–3.675	0.3261
Lumbago	90	9 (37.50%)	81 (35.68%)	0.031	0.4415–2.526	0.8599
Orbital pain	51	8 (33.33)	43 (18.94%)	2.776	0.8811–5.281	0.0957
Cough & expectoration	44	6 (25.00%)	38 (16.74%)	1.024	0.6283–4.445	0.3115
Nausea & vomiting	38	5 (20.83%)	33 (14.54%)	0.669	0.5965-4.500	0.4132
Chest distress	26	2 (8.33%)	24 (10.57%)	0.117	0.1698–2.956	0.7321
Dyspnea	19	1 (4.17%)	18 (7.93%)	0.439	0.04633-3.276	0.5075
Pruritus	6	0 (0.00%)	6 (2.64%)	0.649	0.000-7.130	0.4201

* indicates significance ($p<0.05$). NA is not available

Table 5 Laboratory test results (%, $n=251$)

Test	*n* (%)	Non-child group($n=227$)	Child group($n=24$)
Blood RT ($n=251$)			
White blood cell count ($WBC<3.5\times10^9/L$)	92 (36.65%)	76 (33.48%)	16 (66.67)
White blood cell count [$WBC=(3.5–9.5)\times10^9/L$]	150 (59.76%)	142 (62.56%)	8 (33.33%)
White blood cell count ($WBC>9.5\times10^9/L$)	9 (3.59%)	9 (3.59%)	0 (0%)
Neutrophils count ($N<1.8\times10^9/L$)	66 (26.29%)	51 (22.47%)	15 (62.50%)
Neutrophils count [$N=(1.8–6.3)\times10^9/L$]	163 (64.94%)	154 (67.84%)	9 (37.50%)
Neutrophils count ($N>6.3\times10^9/L$)	22 (8.77%)	22 (8.77%)	0 (0%)
Lymphocyte count ($LY<1.1\times10^9/L$)	206 (82.07%)	196 (86.34%)	10 (41.47%)
Lymphocyte count [$LY=(1.1–3.2)\times10^9/L$]	43 (17.13%)	29 (12.78%)	14 (58.33%)
Lymphocyte count ($LY>3.2\times10^9/L$)	2 (0.80%)	2 (0.80%)	0 (0%)
Monocyte count ($MO<0.1\times10^9/L$)	2 (0.80%)	2 (0.80%)	0 (0%)
Monocyte count [$MO=(0.1–0.6)\times10^9/L$]	195 (77.69%)	172 (75.78%)	23 (95.83%)
Monocyte count ($MO>0.6\times10^9/L$)	54 (21.51%)	53 (23.35%)	1 (4.17%)
Eosinophil count ($EO<0.02\times10^9/L$)	188 (74.90%)	177 (77.97%)	11 (45.83%)
Eosinophil count [$EO=(0.02–0.52)\times10^9/L$]	63 (25.10%)	50 (22.03%)	13 (54.17%)
Eosinophil count($EO>0.52\times10^9/L$)	0 (0%)	0 (0%)	0 (0%)
Basophil count ($BA=0.0\times10^9/L$)	90 (35.86%)	80 (35.24%)	10 (41.47%)
Basophil count ($0.0< BA<0.06\times10^9/L$)	161 (64.14%)	147 (64.76%)	14 (58.33%)
Basophil count ($BA>0.06\times10^9/L$)	0 (0%)	0 (0%)	0 (0%)
Thrombocytopenia ($PLT<125\times10^9/L$)	63 (25.10%)	59 (25.99%)	4 (16.67%)
Hemoglobin dropped (Hb<130 g/L)	86 (34.26%)	76 (33.48%)	10 (41.47%)
Inflammation index ($n=251$)			
C-reactive protein increased (CRP>10 mg/L)	107 (42.63%)	102 (40.64%)	5 (20.83%)
Kidney function test ($n=26$)			
Serum creatinine increased (Cr>90μmol/L)	4 (15.38%)	4 (15.38%)	0 (0%)
Urea nitrogen (UN>7.8mmol/L)	0 (0%)	0 (0%)	0 (0%)
Uric acid (UA>430μmol/L)	0 (0%)	0 (0%)	0 (0%)
Liver function test ($n=34$)			
Alanine aminotransferase increased (ALT>40 U/L)	8 (23.53%)	8 (23.53%)	0 (0%)
Aspartate aminotransferase increased (AST>40 U/L)	13 (38.24%)	13 (35.29%)	1 (2.94%)
Total bilirubin (TBIL>26μmol/L)	2 (5.88%)	2 (5.88%)	0 (0%)
Electrolyte detection ($n=43$)			
Hypoklemia (K<3.5μmol/L)	12 (27.91%)	11 (25.58%)	1 (2.33%)
Hyponatremia (Na<135μmol/L)	28 (65.12%)	26 (60.47%)	2 (13.95%)
Urinalysis ($n=12$)			
U-WBC (male>3/hp, female>5/hp)	2 (16.67%)	2 (16.67%)	0 (0%)
Urine occult blood (>+~~+++)	8 (66.67%)	8 (66.67%)	0 (0%)
Urine protein (>+~~+++)	7 (58.33%)	7 (58.33%)	0 (0%)

Blood RT, Blood routine test; WBC, white blood cell; N, Neutrophils; LY, Lymphocyte; MO, Monocyte; EO, Eosinophil; BA, Basophil; PLT, Thrombocytopenia; Hb, Hemoglobin; Cr, Serum creatinine; UN, Urea nitrogen; UA, Uric acid; ALT, Alanine aminotransferase; AST, Aspartate aminotransferase increased; TBIL, Total bilirubin; U-WBC, Urine white blood cell; CRP, C-reactive protein

Table 6 ROC curve analysis results

	AUC	YI	Cut off	Sensitivity%	Specificity%	95%CI	*P*
WBC	0.836	0.549	5.765	0.761	0.789	0.799–0.872	$P<0.0001$
N	0.811	0.504	3.395	0.867	0.637	0.772–0.850	$P<0.0001$
LY	0.725	0.386	0.925	0.633	0.753	0.678–0.771	$P<0.0001$
PLT	0.752	0.399	182.5	0.734	0.665	0.708–0.796	$P<0.0001$
CRP	0.635	0.223	7.420	0.729	0.494	0.585–0.686	$P<0.0001$

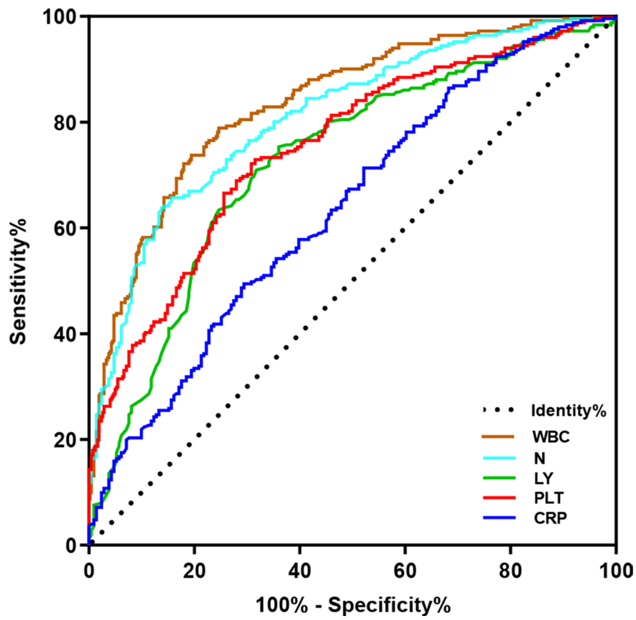

Fig. 5 The analyze the diagnostic value of WBC, N, LY, PLT, and CRP for DF. WBC: AUC = 0.926(95% CI: 0.870–0.983); N: AUC = 0.898 (95% CI: 0.830–0.967); LY: AUC = 0.727 (95% CI: 0.613–0.840); PLT: AUC = 0.727 (95% CI: 0.613–0.840); CRP: AUC = 0.727 (95% CI: 0.613–0.840). *Abbreviation* AUC, area under the curve. CI, confidence interval; ROC, receiver operating characteristic; WBC, white blood cell; N, Neutrophils; LY, Lymphocyte; PLT, Thrombocytopenia; CRP, C-reactive protein

traditional Chinese medicine, the YiQiQuWen decoction was administered to clear heat and detoxify, and the course of treatment was 3–5 days. After early diagnosis and treatment, the prognosis of all patients was good and there were no deaths.

Discussion

DF is an infectious disease that is seriously harmful to human health in China. Its geographical distribution includes 128 countries and affects 390 million people each year, causing substantial morbidity and mortality in children and adults worldwide [7]. Because most dengue cases have no apparent symptoms or mild symptoms and recover with self-management, many cases are much higher than reported, and many cases are misdiagnosed as other febrile diseases [8]. Owing to the lack of specificity of clinical symptoms, this infectious disease is easily misdiagnosed, and some patients may progress to severe DF. Moreover, there is no approved or registered vaccine to prevent DF in China, so it is necessary to be vigilant about the occurrence of this disease [9]. The DF epidemic in China is mainly characterized by local transmission caused by overseas importation. The reported cases are mainly distributed in the southern regions, such as Guangdong, Yunnan, and Fujian. Aedes mosquitoes, which are vectors suitable for dengue virus transmission, are widely distributed; therefore, the disease can easily prevail in southern provinces [10]. The second generation of local epidemics of DF occurred frequently in Fuzhou, Fujian Province, mainly due to imported DF. The epidemic situation of local DF in Fuzhou was highly sporadic with local outbreaks, the epidemic spots were scattered, and the population was generally susceptible [11]. Second-generation DF cases were defined as those who were infected with dengue virus after being bitten by mosquitoes in epidemic areas outside China, and then transmitted to uninfected patients after returning to China. DF cases in Fuzhou are mainly imported, and most of the patients are imported from outside Southeast Asia. The lack of timely prevention and control may have caused DF infections in the population of Fuzhou. A total of 523 local cases of DF were reported in Fuzhou in 2019, with an incidence rate of 7.18/100 000, which was significantly higher than those in 2017 and 2018, becoming the second highest in the past seven years. Three years after the COVID-19 epidemic, the number of dengue cases in China decreased significantly, which is related to strict epidemic prevention and control measures [12]. In 2023, the first year after the elimination of COVID-19 prevention and control measures, DF outbreaks occurred again in many places, and the number of cases in the Fuzhou urban area increased significantly. This also indirectly proved that DF in China was not localized but was still caused by local secondary transmission caused by imported cases. Surveillance and timely detection of imported cases of DF are essential for controlling the local epidemic of DF. Through retrospective analysis of DF in Fujian Second People's Hospital, this study indirectly reflects the epidemiological distribution of DF in the Fuzhou urban area of Fujian Province to understand the incidence characteristics and influencing factors in this area. To provide scientific evidence for DF prevention and treatment and to formulate measures to reduce the public health burden and promote people's health.

According to the demographic statistics of this study, the age distribution characteristics of the population were relatively consistent with those of the previous years. The incidence rate was higher in people aged 20–59 years, mainly in young adults, and there was no difference in the incidence rate between men and women. The age distribution is roughly the same as the results of some domestic studies, but the results of gender studies are slightly different [13]. The occupational distribution was primarily retirees, cadres, commercial service personnel, and students. Compared with previous studies, it was found that the population in this case was diverse, with no focus on people who often spent time outdoors. This indicates that DF exposure can occur indoors or outdoors. This indirectly warns that many industries in this region must pay more attention to DF prevention and control measures [14]. This also shows that the infected population is universal; without unique prevention and control, all occupational populations can develop the disease. This study also analyzed the living floor environment of the patients, and 60.61% of them lived on the lower floor (third floor and below). People on lower floors may be more susceptible to the disease, which is related to the mosquito's lifestyle. Mosquitoes usually move and breed in low-lying, moist areas, especially those with nearby water bodies such, as pools and potted plants. Because low-floor housing may be closer to these breeding environments, people living in these places are at a relatively high risk of exposure to mosquitoes and dengue virus infection. The lower floors are closer to the ground, and the air humidity is higher, which favors mosquito survival. This increases the risk of low-floor residents being biting and therefore, is more likely to be infected with DF. Therefore, people living on the lower floors should strengthen their environmental hygiene management and do an excellent job for mosquito control.

Fuzhou is located on the southeast edge of Eurasia, facing the Pacific Ocean in the east, and has a typical subtropical monsoon climate. The central urban districts include Jin'an District, Gulou District, Taijiang District, Cangshan District, Mawei District, and Minhou County, ranging from 25 15' to 26 39' north latitude and 118 08' to 120 31' east longitude [15]. By 2023, the area had a permanent population of 8.29 million, making it the principal endemic location for DF in Fujian Province. Based on the population proportion and number of patients, the prevalence of each district (county) can be indirectly assessed according to the population proportion. Jin'an District had 132 cases, accounting for 52.59% of the total. Ninety cases were treated in Gulou district, accounting for 35.86% of the total cases. The number of patients in Cangshan District, Taijiang District, Mawei District, and Minhou County was lower, which might be related to nearby hospitals. Jin'an District is located in the north of Fuzhou. The central terrain is mountainous, with dense forests, shrubs, weeds, mountain streams, and rivers all over the upper Minjiang River, and the external environment is suitable for mosquito breeding. Fuzhou's surface vegetation coverage map shows that Fuzhou's forest coverage rate is very high, and mountains and hills account for approximately two-thirds of the total land area of the region. The geomorphology is a typical estuary basin; its altitude is mostly between 600 and 1000 m, and the urban area is small and relatively concentrated. The SDE map for different months showed that the spatial distribution was mainly in the city center, and the number of reported cases and incidence rates decreased, with Jin'an District and Gulou District being the highest. Most of the cases occurred in densely populated areas, mainly at the junction of urban and rural areas, with poor sanitary environments and many mosquito breeding containers. Additionally, the expansion of urban greenery provides more habitats for adult mosquitoes, which is one of the reasons for the high incidence of DF among community residents. In conclusion, habitat complexity and diversity of land cover are essential drivers of disease emergence. Therefore, it is necessary to focus on prevention and control in these six places and strengthen health education.

The weather in Fujian Province is hot from July to September, which is the period of concentrated typhoon activity. On average, typhoons land directly in the city twice a year. On September 5, 2023, heavy rainfall caused by Typhoon "Haikui" caused flooding in Fuzhou and DF became prevalent thereafter. Studies have shown that the transmission of DF is affected by the density of mosquito vectors, and the main meteorological factors affecting mosquito density are air temperature and humidity, of which temperature is the determinant factor of mosquito density [16]. Seasonal decomposition analysis indicated that the number of DF cases was highest in autumn, followed by summer. According to the National Bureau of Disease Control and Prevention data, DF broke out again after the opening of the COVID-19 epidemic, and the number of DF infections in 2023 increased significantly compared to the previous three years. The national dengue epidemic in 2023 has increased significantly from July to November. It showed a downward trend until November, and the heat map also showed that September and October were the peaks of incidence. The heat map statistics showed that there were incidence peaks of DF in Fuzhou. A prominent epidemic peak occurred from September to November of the year. Almost no cases from January to July belonged to this region's static phase of the DF epidemic, indicating that the disease had a typical seasonality. On the one hand, the high incidence of the epidemic this year is due to climatic factors. The high temperatures, more rain, and waterlogging caused by typhoons in Fuzhou are all suitable conditions for mosquito breeding. In addition, humans spend the longest time outdoors in summer and autumn, increasing the chance of contact with mosquitoes. Therefore, it is best to wear long pants and long-sleeved clothes in summer and autumn to avoid exposure to grass for long periods and reduce the chance of being bitten by mosquitoes.

Diagnosing and treating this disease is not timely; severe complications may occur and may even be life-threatening, so primary doctors should improve their understanding of this disease. The main pathological changes in DF are systemic microvascular damage, resulting in increased vascular permeability, exudation of plasma proteins and blood-formed components, and blood concentration, hemorrhage, shock, and other pathophysiological changes [17]. It can involve multiple systems and organs, and its diverse clinical manifestations make it easy to misdiagnose. This study included 251 patients with DF, and 100% had fever as the first diagnosis. The most common clinical symptom of DF is fever, which is characterized by acute and high fever [18]. In this study, the main symptoms of acute onset were fever, fatigue, muscle aches, headache, and chills, with fever being the most common. The main signs included rash and lymphadenopathy. The detection rate of rash was 26.29%, which was common in the limbs and trunk, less common in the face, and congestive rash and bleeding spots were more common. These symptoms are nonspecific and should be distinguished from those of other infectious diseases. At the same time, the symptoms and signs of the child and non-child groups were compared, and there was no significant difference between the two groups.

Laboratory results suggest that DF could affect the functions of multiple systems, including the blood system, liver, kidneys, coagulation, and various inflammatory indicators. In this study, 36.65% of the patients with scrub typhus had reduced white blood cell counts and 26.29% had reduced neutrophil counts, suggesting that white blood cell and neutrophil levels can be used as an auxiliary examination method. Although most patients had fever, white blood cells were maintained within the normal range. This study showed that 59.76% of the patients had normal white blood cells and 64.94% had normal neutrophils. Thrombocytopenia was found in some patients, which may be related to the inhibition of the platelet system in the bone marrow by the dengue virus [19]. Thrombocytopenia can also be used as an auxiliary test for DF. Through the detection of liver and kidney function in some patients, the results showed a certain degree of liver and kidney function impairment, including 15.38% abnormal creatinine, 38.24% AST, and 23.53% elevated ALT, indicating that this disease may lead to multiple organ dysfunction. Many patients also exhibit electrolyte metabolism disorders and do not pay attention to rehydration, which can easily lead to dehydration, of which hyponatremia can reach 65.12% and hypokalemia 27.91%; therefore, attention should be paid to the stability of the internal environment. The positive rate of urinary occult blood was 66.67%, and that of urinary protein was 58.33%. CRP levels increased in 42.63% of the patients with specific reference values. This project also analyzed white blood cells, neutrophils, lymphocytes, platelets, CRP, and other indicators using ROC curve analysis and found that the specificity and sensitivity of white blood cells were high. Among them, the sensitivity of neutrophils was higher than that of lymphocytes and the specificity was lower than that of lymphocytes. Elevated CRP levels and decreased platelet counts also have specific diagnostic value. Because of the advantages of simple and cheap routine blood tests and CRP, the combined detection of these indicators has good clinical application value.

The positivity rates of serum NS1 antigen, IgM antibody, and IgG antibody were 97.61%, 15.14%, and 0.40%, respectively. We also compared the pathogens between the child and non-child groups, and the results showed that the positive rate of serum NS1 antigen in the non-child group was higher than that in the child group. In contrast, the positive rate of serum IgM and IgG antibodies was lower than that in the pediatric group. The early use of serum NS1 antigen detection can improve positivity, provide a basis for early diagnosis, and have high clinical value. NS1 antigen can be detected by ELISA or a rapid detection reagent, which can be detected in tens of minutes to several hours. It is an essential means for diagnosing the acute stage of DF and can be detected one day after the onset of the disease; however, this method cannot be used for serotyping. The low positivity rate of the antibody in the early stage may be related to the complex composition of dengue serum and the late appearance of the antibody [20]. If DF is suspected (five days after onset), a DF-specific antibody test or next-generation sequencing detection technology (NGS) should be performed immediately. Therefore, clinicians should not rely solely on laboratory tests to diagnose dengue but should combine patients' epidemiology and clinical manifestations to avoid delaying the disease diagnosis.

The prognosis of DF is closely related to timely diagnosis. Inexperienced doctors are often prone to missed diagnoses; therefore, they must be trained in relevant knowledge. Given the excellent effect of traditional Chinese medicine in the treatment of viral infection, patients were given the YiqiQuWen prescription (Huangqi 15 g, Baizhu 10 g, Fangfeng 6 g, Mabiancao 15 g, boiled water can be taken twice a day), which has beneficial qi solid surface, clearing heat and detoxification effects, and can shorten the course of the disease. Clear heat and detoxification are terms used in traditional Chinese medicine, which is equivalent to the antiviral effect of Western medicine. The YiQiQuWen decoction has the effect of clearing heat and detoxifying, which can be understood as having an antiviral effect on the dengue virus. Most patients' symptoms improved significantly after treatment with Chinese and Western combinations, reflecting the advantages of traditional Chinese medicine in treating viral infectious diseases. Patients with unexplained fever must undergo careful physical examination and other relevant clinical symptoms to investigate whether they have DF. Therefore, improving the understanding of DF, reducing misdiagnosis, and improving early diagnosis are key to treatment.

Conclusion

The surveillance of mosquito vectors and dengue cases, risk assessment, and emergency preparedness should be carried out in all urban areas of Fuzhou, and the awareness of dengue prevention should be strengthened in all industries, especially in the Jin'an and Gulou Districts. Timely detection of imported cases and the local epidemic caused by imported cases to control the epidemic in the early stages. During the DF epidemic, a correct clinical diagnosis should be made as soon as possible based on the patients' epidemiological data, symptoms, signs, and auxiliary examinations. Owing to the lack of specific drugs for this disease, TCM treatment is recommended and the course of treatment is shortened.

The data in this study came from a single research center and was a retrospective analysis with certain limitations. The relationships between potentially influential factors in climatic, geographical, and environmental aspects and DF incidence in Fuzhou City will be explored further.

Abbreviations

DF	Dengue fever
BRT	Routine blood test
WBC	White blood cell
N	Neutrophils
LY	Lymphocyte
MO	Monocyte
EO	Eosinophil
BA	Basophil
PLT	Thrombocytopenia
Hb	Hemoglobin
Cr	Serum creatinine
UN	Urea nitrogen
UA	Uric acid
TB	Total bilirubin
ALT	Alanine aminotransferase
AST	Aspartate aminotransferase increased
U-WBC	Urine white blood cell
SDE	Standard deviation ellipse
NGS	Next-generation sequencing detection technology

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Author contributions
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Data availability
The datasets used and analyzed in this study belong to our research team and do not include personal privacy information. The datasets are available from the corresponding authors upon request.

Declarations

Ethics approval and consent to participate
The ethical certificate number of the project researcher is No.2024464. This retrospective study mainly described the epidemiology and clinical manifestations of dengue fever based on the medical records of patients. This is a descriptive study did that not involve human specimens, such as tissue and blood, and did not cause harm to patients. All materials were submitted for ethical approval, including the initial review materials, clinical study protocol, application for waiver of informed consent, case report form, investigator manual, and statement of economic interest. Ethical approval for this study was obtained from the Ethics Committee of the Second Affiliated Hospital of the Fujian University of Traditional Chinese Medicine. All data of cases used in this study were anonymized, and personal identification information (e.g., name and street address) was not included. Because the data were anonymized, the requirement for informed consent was waived.

Consent for publication
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