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EC MICROBIOLOGY
Research Article

Evaluation of White Blood Cell Parameters in Patients with Typhoid Fever in Shendi Town, Sudan: A Cross-Sectional Study

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Received: May 19, 2025; **Published:** June 24, 2025

Abstract

Salmonella typhi causes typhoid fever, an acute and unknown infection of the reticuloendothelial system that results in significant hepatic problems and biochemical alterations. Although serologic tests are still frequently performed, the diagnostic test of today is the isolation of bacteria from blood, faeces and infrequently, urine. A quick and accurate typhoid fever test still has to be developed. This study illuminates the diagnosis of typhoid fever in resource-limited settings. The present study aimed to evaluate the white blood cell parameters among patients with typhoid fever in Shendi City. This descriptive cross-sectional analytical study was conducted in Shendi Town, River Nile State, from January to April 2025. It included 70 participants: 40 blood samples from typhoid fever patients of different ages and sexes were used as the test group, and 30 healthy individuals were selected randomly as the control group. White blood cell parameters were measured using standard techniques with a CBC automated hematological analyzer (MindaryBC 3000), and the results were analyzed using SPSS 26 for Windows. Results showed that the mean values of white blood cells (4.165), differential counts of lymphocytes and granulocytes (45.8, 11.52, 45.8, 11.52, 41.9), and absolute counts of lymphocytes and granulocytes (1.89, 475, 1.75) in the test group were significantly reduced compared to the mean values of white blood cells (7.19), differential counts of lymphocytes and granulocytes (35.33, 9.347, 56.766), and absolute counts of lymphocytes and granulocytes (7.530, 4.093) in the control group ($P < 0.05$). In conclusion, typhoid fever affects hematological parameters significantly.

Keywords: *Typhoid; Leukopenia; WBC Parameters; Diagnosis; Shendi*

Introduction

Typhoid fever is a major public health concern in many developing countries of the world as well as developed countries [1]. It is endemic in the tropics and the second most common cause of fever after malaria. Typhoid fever is caused by *Salmonella typhi*, and infection is usually acquired through the ingestion of urine or feces of infected carriers by humans in contaminated water or food. It mainly affects children and young adults, causing a global morbidity rate of over 12.6 million cases and an estimated 600000 mortalities annually [2]. The attack rate as high as 1100 cases per 100000 population has been documented in developing countries [3]. The primary source of the disease is poor sanitary hygiene, especially drinking water and food contamination, hence, direct fecal-oral transmission is most common [4-7]. The transmission also occurs through eating raw fruits and vegetables fertilized by human excreta and through ingestion of contaminated milk and milk products whenever they are not well decontaminated. Flies act as a mechanical transporter of the bacteria to cause human infection through the transfer of the infectious agents to food. Pollution of water sources produces epidemics of typhoid

fever, usually when a large number of people use the same source of drinking water [6,8]. If left untreated, typhoid fever has a mortality rate close to 10 or 15%, reducing to one or two percent with adequate and timely antibiotic treatment [9,10]. Some reviews report that in children under four years, lethality is 10 times higher than in older children [11]. The white blood cells (leucocytes) may be divided into two broad groups: the phagocytes and the immunocytes. Granulocytes, which include three types of cell-neutrophil (polymorphs), eosinophils, and basophils together with monocytes, comprise the phagocytes. Their normal development and function, and benign disorders of white blood cells. Only mature phagocytic cells and lymphocytes are found in normal peripheral blood. The lymphocytes, their precursor cells, and plasma cells, which make up the immunocyte population [12]. The function of phagocytes and the immune system in protecting the body against infection is closely connected with two soluble protein systems of the body are immunoglobulin and complement. These proteins, which may also be involved in blood cell destruction in several diseases. The white blood cell differential count determines the number of each type of white blood cell (Neutrophils, eosinophils, basophils, lymphocytes, and monocytes) present in the blood [12]. So in this study, we aim to compare the WBC parameters findings among typhoid patients and healthy individuals, and come up with some differentiating parameters that can be used as diagnostic markers for typhoid fever.

Materials and Methods

Study design

This is a descriptive cross-sectional analytical study, which aimed to evaluate white blood cell parameters in patients with typhoid fever.

Study area

This study was done in Shendi city, River Nile State, Northern Sudan.

Study duration

This study was done during the period from January to April 2025.

Study populations

Participants involved in this study were typhoid patients.

Inclusion criteria

Typhoid patients were included in this study, and other healthy people served as a control group.

Exclusion criteria

People who have another disease, with typhoid infection.

Sample size

There were 40 blood samples of typhoid patients with different age and sex groups as the test group, and 30 healthy people were selected randomly as a control group.

Sample processing

Three ml of venous blood samples were collected by standard procedure in evacuated EDTA blood containers.

White blood count and differential count

White blood count and differential count were performed using the Mindray BC-3000 plus automated hematology analyzer.

Principle of the method

Blood cells can be broadly divided into three categories. Red blood cells, white blood cells, and platelets. The analyzer measures the number of cells and distinguishes between their types according to size using sheath flow DC detection. Electrical current is passed through a solution; this method measures the changes in electrical resistance that occur when blood cells pass through the detection aperture. This instrument performs haematology analyses according to the RF/DC detection method, Hydro Dynamic Focusing (DC Detection), and sodium lauryl sulphate (SLS) hemoglobin method. The radio frequencies and direct current (RF/DC detection method) detect the volume of blood cells by changes in direct-current resistance.

WBC measurement

WBCs are counted and sized by the Coulter method. This method is based on the measurement of changes in electrical resistance produced by a particle, which in this case is a blood cell, suspended in a conductive diluent as it passes through an aperture of known dimensions. An electrode is submerged in the liquid on both sides of the aperture to create an electrical pathway. As each particle passes through the aperture, a transitory change in the resistance between the electrodes is produced. This change produces a measurable electrical pulse. The number of pulses generated signals the number of particles that passed through the aperture. The amplitude of each pulse is proportional to the volume of each particle. Each pulse is amplified and compared to the internal reference voltage channels, which only accept the pulses of a certain amplitude. If the pulse generated is above the WBC threshold, it is counted as a WBC [13].

Principles of ICT for typhoid detection

The typhoid rapid test cassette is a qualitative, membrane-based immunoassay for the detection of antibodies (IgG and IgM) to *Salmonella typhi* (*S. typhi*) in human serum or plasma. The diagnostic test cassette consists of two components: an IgG component and an IgM component. The IgG line region is pre-coated with reagents for the detection of anti-*S. typhi* (IgG). The IgM line region is pre-coated with monoclonal anti-human IgM for the detection of anti-*S. typhi* (IgM). During testing, the specimen dispensed into the sample well of the test cassette binds with Typhoid conjugates impregnated in the reagent area, if the specimen contains anti-Typhoid antibodies. The immunocomplex thus formed migrates by capillary action. If the present antibodies in the specimen are of IgG type, the immunocomplex is then captured by the pre-coated reagents on the membrane, forming a colored IgG line, indicating a *S. typhi* IgG positive test result. If the present antibodies in the specimen are of IgM type, the immunocomplex would be captured on the membrane by the pre-coated human IgM antibody, forming a colored IgM line, indicating a *S. typhi* IgM positive test result. Absence of any T lines (IgM and IgG) indicates a negative result. A colored control line (C) should always appear in case of a positive or a negative result. Its absence indicates invalid test results [14].

Data analysis

Data are calculated and analyzed using SPSS 26.0 statistical package. Mean values are obtained, and the frequencies and percentages of other variables are calculated and displayed in numerical and tabular form. The P-value is used to assess the significance of the results.

Results

Gender	Frequency	Percent %
Male	23	57.5.0
Female	17	42.5.0
Total	40	100.0

Table 1: *The gender distribution among the case population.*

Age	Frequency	Percent %
More than 30 years	21	52.5.0
Less than 30 years	19	47.5.0
Total	40	100.0

Table 2: *The age distribution among the case population.*

Parameters	Type	No	Mean	P. value
TWBCs	Case	40	4.165	0.000
	Control	30	7.197	
Lymph%	Case	40	45.80	0.000
	Control	30	35.33	
Mid %	Case	40	11.520	0.007
	Control	30	9.437	
Gran%	Case	40	41.9000	0.000
	Control	30	56.7667	
Abs lymph	Case	40	1.892	0.000
	Control	30	2.530	
Abs Mid	Case	40	.475	0.000
	Control	30	.680	
Abs Gran	Case	40	1.753	0.000
	Control	30	4.093	

Table 3: *Comparison of the mean of WBC parameters in the case group and the control group.*

Parameters	Age	No	Mean	P. value
TWBCs	Less than 30 years	19	4.032	0.564
	More than 30 years	20	4.286	
Lymph%	Less than 30 years	19	45.80	0.818
	More than 30 years	20	46.10	
Mid %	Less than 30 years	19	10.574	0.102
	More than 30 years	20	12.376	
Gran%	Less than 30 years	19	43.05	0.515
	More than 30 years	20	40.86	
Abs lymph	Less than 30 years	19	1.795	0.390
	More than 30 years	20	1.981	
Abs Mid	Less than 30 years	19	0.421	0.141
	More than 30 years	20	0.524	
Abs Gran	Less than 30 years	19	1.742	0.939
	More than 30 years	20	1.753	

Table 4: *Comparison of the mean of WBC parameters in the case group according to age.*

Parameter	Gender	No	Mean	P.value
TWBCs	Male	23	4.413	0.186
	Female	17	3.829	
Lymph%	Male	23	46.70	0.440
	Female	17	44.59	
Mid %	Male	23	11.704	0.702
	Female	17	11.271	
Gran%	Male	23	41.26	0.659
	Female	17	42.76	
Abs lymph	Male	23	2.013	0.192
	Female	17	1.729	
Abs Mid	Male	23	0.517	0.158
	Female	17	0.418	
Abs Gran	Male	23	1.830	0.479
	Female	17	1.647	

Table 5: *Comparison of the mean of WBC parameters in the case group according to gender.*

Discussion

Significant liver issues and biochemical abnormalities are caused by typhoid illness. Although bacterial culture is currently the most successful diagnostic method, serologic testing is still frequently employed, and a quick and precise typhoid fever diagnostic test is still necessary. Haematological abnormalities are used to diagnose typhoid illness and assess its prognosis. This is a descriptive cross-sectional analytical study conducted at Shendi Town- River Nile State in the period between January to April 2025 to evaluate the white blood cell parameters in typhoid fever patients in Shendi city. It included 70 participants,40 blood samples of typhoid fever patients with different age and sex groups as the test group, and 30 healthy people were selected randomly as a control group. An automated hematology analyzer (Mindray BC3000 plus) was used to analyze hematological indices. This study shows that the mean of TWBCs in typhoid fever patients was (4.165) in the case and (7.197) in the control group, which has a statistically significant decrease with P-value (0.000). This agrees with published data made by Tanka [15], King Edward [16], Ozougwu JC [17], Uzma Ishaq [18] and Singh [19]. The mean of differential count of Lymph, Mid, and Gran in the case were (45.8, 11.5, 41.9) and (35.33, 9.347, 56.766) respectively. The control group had a statistically significant decrease with a P-value of (0.000), which agrees with the result published by Tanka [15]. The mean of absolute count of lymph Mid and Gran in cases were (1.892, 475, 1.753) and (7.530, 680,4.093) respectively in the control group, which shows statistically significant decrease with P-value (0.000), which agrees with the data published by Tanka [15]. The statistical analysis of results of this study showed that there was no significant variation in the mean of WBCs count, deferential count (lymph, mid, Gran), and absolute count (lymph, mid, Gran), in patient with typhoid fever according to the gender (male and female) with P-value (0.186 - 0.440 - 0.702 - 0.659 - 0.192 - 0.158 - 0.479) respectively. The statistical analysis of result of this study showed that there was no significant variation in the mean of WBCs count, deferential count (lymph, mid, Gran), and absolute count (lymph, mid, Gran) in patient with typhoid fever according to the age (less than 30 years, more than 30 years) with P-value (0.564 - 0.818 - 0.102 - 0.515 - 0.390 - 0.141 - 0.939) respectively.

We found that leucocyte counts were greater in typhoid patients. Patients also showed low lymphocyte percentages and high neutrophil percentages in the differential leucocyte count. According to earlier research, neutrophil numbers rise while lymphocyte counts fall

under a variety of stressful conditions. While lymphocytopenia is caused by lymphocyte redistribution, margination within the lymphatic system, and an increase in apoptosis, increased neutrophil numbers are the consequence of demargination, delayed neutrophil apoptosis, and growth factor-induced stem cell activation. Wyllie., *et al.* concluded that lymphocytopenia is a predictor of bacteremia in typhoid fever patients after they discovered the clinical utility of lymphocytopenia as a marker for identifying bacteremia in emergency departments. Despite their high frequency and severity, liver involvement and hematological changes are only transient. Lymphocytopenia is a sign of typhoid infection. Furthermore, the NLCR is significantly more important for diagnosing typhoid illness. This marker is straightforward, easy to calculate and obtain, simple to incorporate into routine exercise, and cost-free. Typhoid fever significantly impacts certain hematological parameters. These alterations may aid in its diagnosis. As a result, clinicians should request Full Blood Count Tests early for timely and effective typhoid infection diagnosis and appropriate patient treatment, while closely monitoring these hematological parameters.

Conclusion

Most cases are leukopenia with total white blood cells less than the normal level. There highly significant decrease in mean TWBCs count, differential count, of lymph, mid, and gran, and absolute count of lymph, mid, and gran, when this result is compared with the health control group. This distinctive pattern of WBC data, which is easy to obtain using a minimally invasive technique, can be used to diagnose typhoid disease.

Recommendations

1. Regular investigations should be conducted on mothers who are pregnant mothers.
2. Women who are pregnant should take vitamins consistently throughout their pregnancy.
3. More research on red blood cell parameters during pregnancy is necessary.
4. Raising pregnant women's understanding of how to manage their health and safeguard themselves against complications.

Limitations

While this is the first research from Shendi City, Sudan, focusing on the Evaluation of Red Blood Cell Parameters in Pregnant Women, it is still a single-center study with a limited sample size.

Consent

The patient's written consent has been collected.

Ethical Approval

The study was approved by the Department of Hematology in the College of Medical Laboratory Sciences at Shendi University. The study matched the ethical review committee board. Sample collection was done after agreement with the participants. The aims and benefits of this study were explained with the assurance of confidentiality. All protocols in this study were done according to the Declaration of Helsinki (1964).

Sources of Funding

There was no specific grant for this research from any funding organization in the public, private, or nonprofit sectors.

Conflict of Interest

The authors have declared that no competing interests exist.

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Volume 21 Issue 7 July 2025