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# RELATIONSHIP BETWEEN WIDAL TITER WITH C-REACTIVE PROTEIN (CRP) LEVELS AND SEGMENTED NEUTROPHIL PERCENTAGE IN CHILDREN WITH TYPHOID FEVER AT GRAHA MEDIKA MARTAPURA CLINIC, BANJAR DISTRICT

**Eka Wahyuni[1*], Puspawati[1,2,3], Muhammad Arsyad[1], Syihab Fayumi[3]**
[1]Program studi Diploma III Analis Kesehatan, Fakultas Ilmu Kesehatan dan Sains Teknologi, Universitas Borneo Lestari
[2] Departemen Patologi Klinik, Rumah Sakit Umum Daerah Ratu Zalecha, Indonesia
[3]Klinik Graha Medika, Indonesia
Email : eka783330@gmail.com

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**Abstract**
Typhoid fever is an infectious disease that remains a public health problem in Indonesia, particularly among children. Infection with Salmonella typhi can trigger an inflammatory response characterized by elevated C-reactive protein (CRP) levels and changes in the percentage of segmented neutrophils. The Widal test is still widely used to aid in the diagnosis of typhoid fever because it is simple, rapid, and cost-effective. This study aimed to determine the relationship between Widal titers and CRP levels and the percentage of segmented neutrophils in pediatric typhoid fever patients at the Graha Medika Martapura Clinic, Banjar Regency. This study employed an observational analytical method with a cross-sectional design. The data used were secondary data from the medical records of pediatric typhoid fever patients from January 2025 to March 2026. The study sample consisted of 206 patients selected using total sampling. Data analysis was performed using the Spearman rank correlation test. The results showed that the majority of patients had a Widal titer of 1/640 (65.5%), elevated CRP levels (59.7%), and a normal percentage of segmented neutrophils (84.5%). The correlation test results showed no significant association between the Widal titer and CRP levels (r=0.073; p=0.296) or the percentage of segmented neutrophils (r=0.064; p=0.361). It was concluded that the Widal titer is not associated with CRP levels or the percentage of segmented neutrophils in pediatric patients with typhoid fever.

**Keywords:** Typhoid fever, Widal titer, C-reactive protein (CRP), segmented neutrophils, Salmonella typhi.

## INTRODUCTION

Typhoid fever remains a common infectious disease, particularly in developing countries in tropical and subtropical regions. Caused by Salmonella typhi infection, this disease is clinically characterized by fever accompanied by abdominal pain (Nurmansyah *et al*., 2025). Globally, the number of typhoid fever cases is estimated to reach 11–21 million annually, with a mortality rate of around 128,000 to 161,000 (Khairunnisa *et al*., 2020). This high incidence indicates that typhoid fever remains a public health problem that requires attention in terms of diagnosis and monitoring of patient clinical conditions.

Indonesia still ranks third in the world in the number of typhoid fever cases, with an incidence of around 350–810 cases per 100,000 population and a mortality rate of 3.1–10.4%, which is largely influenced by late diagnosis and treatment (Mitha, *et al*., 2023). This disease can affect all age groups, but the highest prevalence is found in children aged 5 to 14 years due to high outdoor activities, low attention to personal hygiene, and the habit of consuming food carelessly which increases the risk of transmission (Wardani, *et al*., 2025; Nurmansyah, *et al*., 2025). The transmission of typhoid fever is also influenced by various risk factors known as the 5F concept, namely food, fingers, fomitus, fly, and feces, so hand hygiene is an important factor in preventing the entry of Salmonella typhi bacteria through the oral route (Qudus, *et al*., 2023).

Salmonella typhi infection triggers an inflammatory response as a defense mechanism through the release of proinflammatory cytokines that stimulate the formation of acute-phase proteins, one of which is C-Reactive Protein (CRP) (Maharani *et al*., 2025). CRP levels increase rapidly in both local and systemic inflammatory conditions and reflect the degree of inflammatory activity during the acute phase of the disease (Djohan *et al*., 2023). In children, the inflammatory response occurs more rapidly because the immune system is still developing, so CRP levels and the percentage of segmented neutrophils can experience changes compared to adults (Bastian *et al*., 2022; Wang *et al*., 2024). Furthermore, segmented neutrophils act as the first line of defense against bacterial infections, so systemic infection will increase neutrophil production and mobilization into the bloodstream and infected tissues, although Salmonella typhi endotoxin can also affect hematopoiesis in the bone marrow (Ndako *et al*., 2020; Kraus & Gruber, 2021).

In clinical practice, one of the tests still widely used to aid in the diagnosis of typhoid fever is the Widal slide test because it is simple, rapid, and relatively affordable (Aminuddin & Putri, 2022). This test detects antibodies to the O, H, and Vi antigens of Salmonella typhi, although only antibodies to the O and H antigens have diagnostic value in establishing typhoid fever (Sw, *et al*., 2025). However, the Widal test has limitations in terms of low sensitivity and specificity (Aminuddin & Putri, 2022). Therefore, a study is needed to examine the relationship between Widal test results and inflammatory indicators such as CRP levels and segmented neutrophil percentage to provide a more comprehensive picture of the infection response in pediatric patients with typhoid fever.

Research conducted by Nurmansyah *et al*. (2025) at the Graha Medika Martapura Clinic showed that most pediatric patients with typhoid fever had leukocyte counts within normal limits and there was no significant relationship between the Widal titer and the total leukocyte count. However, this study was still limited to total leukocyte parameters and did not examine the relationship between the Widal titer and CRP levels or the percentage of segmented neutrophils simultaneously. These limitations indicate the continued need for research linking serological responses with inflammatory parameters in pediatric patients with typhoid fever.

This study aims to determine the relationship between Widal titer and CRP levels and segmented neutrophil percentage in pediatric patients with typhoid fever at the Graha Medika Martapura Clinic, Banjar Regency. This study is important because the increase in Widal titer in Salmonella typhi infection is thought to be related to the inflammatory response indicated by an increase in CRP levels and changes in the percentage of segmented neutrophils. The novelty of this study lies in the analysis of the relationship between Widal titer and two inflammatory parameters, namely CRP levels and segmented neutrophil percentage, simultaneously in pediatric patients with typhoid fever at the Graha Medika Martapura Clinic, Banjar Regency, which has not been studied in previous studies (Nurmansyah, *et al*., 2025).

## METHOD

This is an observational analytical study with a cross-sectional design. The study was conducted using secondary data derived from the medical records of pediatric patients with typhoid fever at the Graha Medika Martapura Clinic, Banjar Regency. The data analyzed included the results of the Widal titer examination, C-Reactive Protein (CRP) levels, and the percentage of segmented neutrophils. The study was conducted at the Graha Medika Martapura Clinic, Banjar Regency, in April 2026, using patient medical records from January 2025 to March 2026.

The research instrument consisted of secondary data obtained from patient medical records, including Widal test results, CRP levels, and leukocyte differential counts to obtain the percentage of segmented neutrophils. Data that met the research criteria were recorded on a data collection sheet, then summarized using Microsoft Excel before being analyzed using the SPSS Statistics 31 application. The independent variable in this study was the Widal titer, which was categorized into low titer (1/160), medium titer (1/320), and high titer (1/640). The dependent variable consisted of CRP levels, which were classified into normal (≤12 mg/L) and increased (>12 mg/L), and the percentage of segmented neutrophils, which were categorized into neutropenia (<40%), normal (40–70%), and neutrophilia (>70%). Data analysis was performed using the Spearman Rank correlation test to determine the relationship between Widal titer and CRP levels and the relationship between Widal titer and the percentage of segmented neutrophils.

The research population was all medical record data of pediatric patients diagnosed with typhoid fever who had complete data on Widal examination results, CRP levels, and complete blood counts at the Graha Medika Martapura Clinic, Banjar Regency during the period of January 2025 to March 2026. The research sample was determined using a total sampling technique, so that all medical record data that met the criteria were used as research samples.

The study began with obtaining a research permit from Borneo Lestari University for the Graha Medika Martapura Clinic in Banjar Regency. After obtaining approval, secondary data were collected, including Widal test results, CRP levels, and segmented neutrophil percentages, from the medical records of pediatric patients with typhoid fever. Data that met the research criteria were then recorded on a data collection sheet, input into Microsoft Excel, and grouped according to the research variables. Data were then checked for completeness and accuracy before being analyzed using SPSS Statistics 31 with the Spearman Rank correlation test.

## RESULTS AND DISCUSSION

### Descriptive Test

**Table 1** Frequency distribution of patients based on Widal antigen titer values

| Variables | Number of patients (frequency) | Percentage (%) |
|---|---|---|
| **Titer 1/320** | 71 | 34.5% |
| **Titer 1/640** | 135 | 65.5% |
| **Total** | 206 | 100% |

Based on table 1, it shows that the highest number of patients were positive in the Widal antigen O titer 1/640, namely 135 patients (65.5%), while the Widal antigen O titer 1/320 was 71 patients (34.5%).

**Table 2** Frequency distribution of patients based on CRP levels

| Variables | Number of patients (frequency) | Percentage (%) |
|---|---|---|
| **Normal CRP** | 83 | 40.3% |
| **CRP increased** | 123 | 59.7% |
| **Total** | 206 | 100% |

Based on Table 2, it shows that there were 123 patients (59.7%) with increased CRP levels and 83 patients (40.3%) with normal CRP levels.

**Table 3** Frequency distribution of patients based on the percentage of segmented neutrophils

| Variables | Number of patients (frequency) | Percentage (%) |
|---|---|---|
| **Neutropenia** | 0 | 0% |
| **Normal** | 174 | 84.5% |
| **Neutrophilia** | 32 | 15.5% |
| **Total** | 206 | 100% |

Based on table 3, it shows that patients with an increased percentage of segment neutrophils were 32 patients (15.5%), the percentage of normal segment neutrophils was 174 patients (84.5%), and the percentage of decreased segment neutrophils was 0 patients (0%).

**Cross Tabulation**

**Table 4** Results of the Widal antigen O titer examination with CRP levels

| Widal titer | Normal CRP | CRP Increased | Total |
|---|---|---|---|
| **1/320** | 31 | 40 | 71 |
| **1/640** | 52 | 83 | 135 |
| **Total** | 83 | 123 | 206 |

The results of the study in table 4 show that patients with increased CRP levels at the Widal antigen titer O 1/320 were 40 patients out of 71 patients (56.3%), patients with normal CRP levels at the Widal antigen titer O 1/320 were 31 patients out of 71 patients (43.7%), patients with increased CRP levels at the Widal antigen titer O 1/640 were 83 patients out of 135 patients (61.5%), and patients with normal CRP levels at the Widal antigen titer O 1/640 were 52 patients out of 135 patients (38.5%).

**Table 5** The results of the Widal antigen O titer examination with the percentage of segmented neutrophils

| Widal titer | Neutropenia | Normal | Neutrophilia | Total |
|---|---|---|---|---|
| **1/320** | 0 | 61 | 10 | 71 |
| **1/640** | 0 | 113 | 22 | 135 |
| **Total** | 0 | 174 | 32 | 206 |

The results in Table 5 show that most patients had a normal percentage of segmented neutrophils, both at Widal antigen O titers of 1/320 (61 patients; 85.9%) and 1/640 (113 patients; 83.7%). Meanwhile, an increased percentage of segmented neutrophils was found in 10 patients (14.1%) with a titer of 1/320 and 22 patients (16.3%) with a titer of 1/640, while no patients were found with a decreased percentage of segmented neutrophils in both titer groups.

**Spearman Rank Correlation Test**

**Table 6** Results of the Spearman correlation test between Widal titer and CRP levels

| Variable | Correlation Coefficient (r) | P value |
|---|---|---|
| **Widal titer with CRP levels** | 0.073 | 0.296 |

The Spearman Rank correlation test results in Table 6 show a correlation coefficient of 0.073 with a p-value of 0.296. Statistically, this indicates that the independent variable (Widal titer) does not have a significant relationship with the dependent variable (CRP) because the p-value is >0.05. Furthermore, the very small correlation coefficient indicates a very weak and positive relationship between the two variables.

**Table 7** The results of the Spearman correlation test between the Widal titer and the percentage of segmented neutrophils

| Variable | Correlation Coefficient (r) | P value |
|---|---|---|
| **Widal titer with percentage of segmented neutrophils** | 0.064 | 0.361 |

The Spearman Rank correlation test results in Table 4.7 show a correlation coefficient of 0.064 with a p-value of 0.361. These results indicate that there is no significant relationship between the Widal titer and the percentage of segmented neutrophils (p > 0.05). Furthermore, a correlation coefficient value approaching zero indicates a very weak relationship between the two variables.

**Discussion**

Based on the results of research on pediatric typhoid fever patients at the Graha Medika Martapura Clinic, Banjar Regency, it was found that the majority of patients had a Widal titer of O antigen 1/640, namely 135 patients (65.5%), while patients with a titer of 1/320 numbered 71 patients (34.5%). These findings indicate that the majority of patients had a high Widal titer. The Widal test is a serological examination used to detect antibodies against Salmonella typhi antigens, especially O and H antigens. The higher the Widal titer found, the greater the likelihood of the body's immune response to Salmonella typhi infection. However, an increase in the Widal titer does not always reflect the severity of inflammation, because the results of this test can be influenced by several factors, such as the duration of the fever, history of previous infections, conditions in endemic areas, and the possibility of cross-reactions with other infections.(Murzalina, 2019).

The results of this study also showed that the majority of patients experienced elevated CRP levels, namely 123 patients (59.7%), while 83 patients (40.3%) had negative CRP levels. Elevated CRP levels in typhoid fever patients may occur due to a systemic inflammatory response caused by Salmonella typhi infection. The lipopolysaccharide component of the bacteria can stimulate immune cells to produce pro-inflammatory cytokines, such as IL-1, IL-6, and TNF-α. These cytokines then stimulate the liver to produce acute-phase proteins, one of which is CRP. Thus, the results of this study are in accordance with the theory that CRP can increase in conditions of bacterial infection and inflammatory processes.(Djohan, et al., 2023).

Although most patients show elevated CRP, some patients still have normal CRP levels. This suggests that the inflammatory response in pediatric typhoid fever patients can vary from person to person. This difference can be influenced by the phase of the disease, duration of the fever, severity of the infection, history of antibiotic use, and the patient's immune system. In patients who are still in the early stages of infection or have received treatment, CRP levels may be lower than in patients experiencing a more active inflammatory process.(Oktoria, et al., 2024).

Based on the results of the examination of the percentage of segmented neutrophils, the majority of patients were in the normal category, namely 174 patients (84.5%). Patients with neutrophilia numbered 32 patients (15.5%), and no patients were found with neutropenia. These results indicate that most of the pediatric typhoid fever patients in this study did not experience a significant increase in the percentage of segmented neutrophils. Neutrophils are one of the main components of the innate immune system that plays a role as the body's first line of defense against bacterial infections. In acute bacterial infections, the number of neutrophils can increase as a form of the body's response to fighting infectious agents.(Kraus & Gruber, 2021).

The percentage of segmented neutrophils in typhoid fever cases is not always marked by an increase. This is related to the nature of Salmonella typhi as an intracellular bacterium that can survive inside macrophages and spread through the reticuloendothelial system. Furthermore, the endotoxin produced by Salmonella typhi can affect bone marrow activity, so the number and percentage of segmented neutrophils in typhoid fever patients can vary. Therefore, the results of segmented neutrophils, which were mostly within normal limits in this study, still correspond to the picture of typhoid fever, as not all typhoid fever patients exhibit neutrophilia.(Haryanti, et al., 2025).

The cross-tabulation results between Widal titer and CRP levels showed that at a Widal titer of 1/320, there were 40 patients (56.3%) with elevated CRP and 31 patients (43.7%) with normal CRP. At a Widal titer of 1/640, there were 83 patients (61.5%) with elevated CRP and 52 patients (38.5%) with normal CRP. Based on these data, increased CRP was more common in patients with a Widal titer of 1/640. However, these results were not strong enough to show a statistically significant relationship.

The Spearman Rank correlation test between Widal titer and CRP levels showed a correlation coefficient of 0.073 with a p-value of 0.296. A p-value greater than 0.05 indicates no significant relationship between Widal titer and CRP levels. Furthermore, a very low correlation coefficient indicates a very weak relationship between the two variables. Therefore, an increase in Widal titer is not always followed by an increase in CRP levels in pediatric typhoid fever patients.

This situation can occur because the Widal and CRP titers reflect two different mechanisms. The Widal titer reflects the humoral immune response in the form of antibody formation against Salmonella typhi antigens, while the CRP reflects the acute inflammatory response produced by the liver. Antibodies detected by the Widal test can remain at high levels even when the inflammatory process begins to subside. Conversely, CRP levels can change more rapidly according to the degree of ongoing inflammation. Therefore, these two parameters do not always increase or decrease simultaneously.(Djohan, et al., 2023).

The cross-tabulation results between the Widal titer and the percentage of segmented neutrophils showed that at a Widal titer of 1/320, there were 61 patients (85.9%) with normal segmented neutrophils and 10 patients (14.1%) with neutrophilia. At a Widal titer of 1/640, there were 113 patients (83.7%) with normal segmented neutrophils and 22 patients (16.5%) with neutrophilia. These results indicate that most patients still had a percentage of segmented neutrophils within the normal range, both at a Widal titer of 1/320 and 1/640.

The results of the Spearman Rank correlation test between the Widal titer and the percentage of segmented neutrophils showed a correlation coefficient value of 0.064 with a p value of 0.361. A p value greater than 0.05 indicates that there is no significant relationship between the Widal titer and the percentage of segmented neutrophils. A correlation coefficient value approaching zero also indicates that the relationship between the two variables is very weak. Thus, an increase in the Widal titer cannot be used to predict an increase in the percentage of segmented neutrophils in pediatric typhoid fever patients.

The results of this study align with previous research, which found that the IgG/IgM typhoid test and the Neutrophil-Lymphocyte Ratio were not significantly associated in typhoid fever patients. These findings support the idea that serological parameters are not always directly related to hematological parameters.(Zerlinda, et al., 2023). Furthermore, the results of this study align with previous research at the Graha Medika Clinic in Martapura, which showed that the Widal titer was not significantly associated with the number of leukocytes and lymphocytes in pediatric typhoid fever patients. This confirms that the Widal titer does not always reflect changes in blood parameters in typhoid fever patients.(Nurmansyah, et al., 2025).

However, the results of this study differ from those that found a significant association between neutrophil count and Salmonella IgM results in pediatric typhoid fever patients. This difference in results may be due to the different types of serological tests used. That study used Salmonella IgM, while this study used Widal titers. The IgM test better reflects acute infection, while the Widal titer can be influenced by a history of previous infections, cross-reactivity, and endemic conditions in a region.(Haryanti, et al., 2025).

The results of this study are also supported by research stating that the neutrophil-lymphocyte ratio can be used as a supporting examination for inflammation in typhoid fever patients. However, in this study, the percentage of segmented neutrophils was largely within normal limits. This indicates that the inflammatory response in typhoid fever cannot be assessed solely from a single hematological parameter, but needs to be combined with other examinations, such as CRP, leukocytes, lymphocytes, NLR, and the patient's clinical condition.(Anggraeni, et al., 2025).

Based on the results of this study, it can be understood that the Widal titer, CRP levels, and the percentage of segmented neutrophils have different roles in describing the condition of pediatric typhoid fever patients. The Widal titer more reflects the antibody response to Salmonella typhi, CRP reflects the acute inflammatory response, while segmented neutrophils reflect the innate immune response to bacterial infection. Therefore, an increase in the Widal titer is not always followed by an increase in CRP levels or a change in the percentage of segmented neutrophils. The results of this study can be formulated as a single indicator for assessing the degree of inflammation or hematological response in pediatric typhoid fever patients. Widal, CRP, and segmented neutrophil examinations should be understood as complementary examinations, not as examinations that can be substituted for each other. Therefore, a comprehensive assessment of pediatric typhoid fever needs to be carried out based on laboratory results and the patient's clinical condition.

## CONCLUSION

Based on the results of this study using secondary data from Widal, C-Reactive Protein (CRP), and segmented neutrophil examinations in pediatric typhoid fever patients at Graha Medika Clinic, Martapura, Banjar Regency, the following conclusions can be drawn:

1. The Widal test results showed that the O antigen Widal titer of 1:640 was the most frequently observed, accounting for 135 patients (65.5%), while a titer of 1:320 was found in 71 patients (34.5%).
2. The CRP examination results indicated that most patients had elevated CRP levels, with 123 patients (59.7%), whereas 83 patients (40.3%) had normal CRP levels.
3. The segmented neutrophil examination showed that the majority of patients had normal segmented neutrophil percentages, comprising 174 patients (84.5%). Neutrophilia was observed in 32 patients (15.5%), while no cases of neutropenia were identified in this study.
4. There was no significant relationship between the Widal titer and CRP levels in pediatric typhoid fever patients at Graha Medika Clinic, Martapura, Banjar Regency. This finding was indicated by a correlation coefficient of 0.073 with a *p*-value of 0.296.
5. There was no significant relationship between the Widal titer and segmented neutrophil percentage in pediatric typhoid fever patients at Graha Medika Clinic, Martapura, Banjar Regency. This finding was indicated by a correlation coefficient of 0.064 with a *p*-value of 0.361.

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