Correlation between Neutrophil Counts and Salmonella IgM in Typhoid Fever Patients at Emanuel Hospital, Banjarnegara

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Abstract

Background: Typhoid fever is an infectious disease caused by Salmonella typhi and remains a significant public health problem in endemic regions. The incidence continues to rise annually, particularly among children. During infection, the immune system responds through both hematological and serological mechanisms, including increased neutrophil counts and the production of Immunoglobulin M (IgM). Neutrophils act as the first line of defense against bacterial invasion, while IgM is the earliest antibody produced during acute infection. Although many studies have independently examined hematological and serological parameters in bacterial infections, limited research has explored the relationship between neutrophil counts and *Salmonella* IgM in pediatric typhoid fever, especially in endemic areas such as Banjarnegara, Indonesia. *Objectives*: This study aims to analyze the relationship between neutrophil counts and Salmonella IgM results in pediatric patients with typhoid fever. *Materials and Methods*: This study is a cross-sectional design utilizing secondary data obtained from the Electronic Medical Records (EMR) and Laboratory Information System (LIS). *Results*: The results showed that 18 patients (47.4%) had normal or high neutrophil counts, while 2 patients (5.3%) had low neutrophil counts. Regarding Salmonella IgM results, 5 patients (13.2%) tested negative, whereas 33 patients (86.8%) tested positive. *Conclusions*: The Spearman statistical test yielded a p-value of 0.002 (p < 0.05) with a correlation coefficient of 0.480, indicating a significant relationship between neutrophil counts and Salmonella IgM results at Emanuel Hospital, Banjarnegara. The correlation between neutrophil counts and Salmonella IgM results is considered moderate.

Keywords

Endemic Area, Neutrophil Count, Pediatric, Salmonella IgM, Typhoid Fever.

1. Introduction

Typhoid fever is a disease caused by the bacterium *Salmonella typhi*, which is transmitted through contaminated food and beverages (Alfaridzi, 2019). According to WHO data in 2021 , there are 11–12 million cases of typhoid fever worldwide each year, with a mortality incidence ranging from

128,000 to 161,000 people. In Indonesia, typhoid fever cases are frequently found in children, with the highest incidence occurring in endemic areas (Parama Cita, 2011). The morbidity rate of typhoid fever in Banjarnegara Regency is relatively high; in 2023, the number of hospitalized typhoid patients at Emanuel Hospital Banjarnegara reached 1,070.

The gold standard for diagnosing typhoid fever is blood culture; however, this method has limited sensitivity, particularly in patients who have received antibiotics, and requires several days to obtain results. Other diagnostic approaches include peripheral blood examinations and serological tests such as the Typhidot, which detects IgM and IgG antibodies against Salmonella typhi membrane proteins(Djohan et al., 2023). The early phase of *Salmonella* infection is indicated by the presence of IgM antibodies, whereas the later phase is marked by an increase in IgG antibodies. A study conducted in North Africa and the United Republic of Tanzania reported that the Typhidot-M kit had a sensitivity of 75% using blood culture as the gold standard (Ilham et al., 2017). Simillary, rapid Salmonella IgG/IgM testing has a sensitivity of 79.3% and a specificity of 90.2% (Nurhidayanti et al., 2023).

The symptoms of typhoid infection are non-specific, similar to other infections, and may include headache, nausea, abdominal pain, muscle pain, joint pain, fever, loss of appetite, and constipation (Levani & Prastya, 2020). This non-specificity highlights the importance of supporting laboratory findings, such as hematological parameters, in diagnosis and disease monitoring.

Leukocytes are blood components that function as part of the body's defense system. Neutrophils are the most abundant type of leukocytes in the blood and serve as the first line of defense during bacterial invasion, showing an increase in number during acute bacterial infections (Hartanto, 2021). Determining the proportion of these cells is useful for assessing whether an acute infection has occurred (Meiwinda Rizky Nurhidayah1, 2021). Routine blood tests can provide information on the composition and count of white blood cells. Lipopolysaccharide endotoxins from Salmonella typhi can cause leukopenia; thus, laboratory results in typhoid patients often show leukopenia and neutropenia. However, severe leukopenia (<2000 cells/µl) is rare (Nugroho et al., 2024).

Several studies have focused on serological tests or hematological parameters independently, yet the relationship between neutrophil counts and Salmonella IgM results remains underexplored. Understanding this correlation may provide additional insights into the immune response to typhoid fever and enhance clinical evaluation in endemic areas. Therefore, this study aims to analyze the relationship between neutrophil counts and Salmonella IgM results in typhoid fever patients at

Emanuel Hospital Banjarnegara.

2. Materials and Methods

2.1. Research Methods

This study employed an observational analytic design with a cross-sectional approach. Data were collected from secondary sources, including the Electronic Medical Records (EMR) and Laboratory Information System (LIS). The study sample consisted of typhoid fever patients aged 5–11 years who tested positive for Salmonella IgG/IgM and underwent neutrophil count examination at Emanuel Hospital, Banjarnegara between January 2025 and June 2025. The data obtained were analyzed using Spearman's correlation test. Ethical clearance was obtained from the Health Research Ethics Committee of Al-Irsyad Cilacap University, with certificate number 2241/280/03.6.1

3. Results and Discussion

3.1. Description of Respondent Characteristics

This section presents the distribution of neutrophil counts and Salmonella IgM results among the study participants. Descriptive statistics, including mean values and categorical distributions, are provided to illustrate the hematological and serological characteristics of pediatric patients with typhoid fever. These data form the basis for further correlation analysis to evaluate the relationship between neutrophil counts and Salmonella IgM.

Typhoid fever is a disease that can affect both adults and children. School-aged children are at high risk of developing typhoid fever (Susanti & Saktiningsih, 2022). Children tend to engage in more physical activities and pay less attention to their dietary habits, often preferring to eat outside or purchase snacks from places with poor hygiene. The highest incidence occurred among six school-aged children, which is related to hygiene factors. Salmonella typhi bacteria primarily multiply in unhygienic food (Mitha S et al., 2021).

Table 1. Description of Respondents' Age

Age (Year)	Frequency (n)	Percentation (%)
5-6	18	47.3
7-8	11	29.0
9-11	9	23.7
Total	38	100.0

Based on table 1, the majority of respondents were typhoid fever patients aged 5 and 6 years, with 9 patients each, accounting for 23.7% of the sample. The smallest group of respondents was 10-year-old patients, consisting of 1 patient (2.6%).

Table 2. Description of Respondents' Gender

Gender	Frequency (n)	Percentation (%)
Man	15	39.5
Woman	23	60.5
Total	38	100.0

Based on Table 2, the majority of respondents in this study were female typhoid fever patients, totaling 23 patients (60.5%), while male patients accounted for 15 patients (39.5%). Typhoid fever can affect all groups, regardless of gender. Gender does not influence the incidence of typhoid fever, as disease transmission is more dependent on personal habits and environmental factors (Susanto, 2020). The transmission of *Salmonella typhi*, primarily through the consumption of contaminated food or water, is affected by handwashing practices with soap, unhygienic food preparation, and access to clean water. These factors have been shown to be more significant than demographic characteristics such as gender (Hardianto, 2019)

3.2. Univariate Analysis

Table 3. Distribution of Neutrophil Counts

Neutrophils Counts	N	%
Low	2	5.3
Normal	18	47.4
High	18	47.4
Total	38	100.0

The average neutrophil count of the study participants was 6,250 ± 1,120 cells/μL (range: 3,200–9,100). Of these, 18 patients (47.4%) had normal or high neutrophil counts, while 2 patients (5.3%) had low counts. Neutrophilia, or an increased number of neutrophils in the blood, often occurs in typhoid fever patients as an immune response to Salmonella typhi infection (Zerlinda et al., 2023). In typhoid patients, Salmonella typhi attacks the digestive tract and causes inflammation, triggering the body's defense mechanisms. Neutrophils, which are a major component of the immune system, increase in number to combat this infection (Ramaningrum et al., 2017). This increase is part of the acute inflammatory response. In some patients, neutrophilia occurs, whereas in others, neutropenia

may develop depending on immune status and the severity of the disease (Putri, 2019).

Patients with secondary infections have lower neutrophil counts compared to those with primary infections. This is also related to the severity of the disease. In patients with primary infections, symptoms are usually mild and accompanied by a decrease in neutrophil counts, but this is not distinct from secondary infections (Rahmi, 2023). After *Salmonella* enters the intestinal mucosal layer, the bacteria are phagocytosed by phagocytic cells. However, the bacteria can survive within these phagocytes, which provides protection for the bacteria to spread throughout the body and shield them from antibodies and antimicrobial agents. As a result, the body does not exhibit a response that increases leukocyte counts (Priskila et al., 2021).

Table 4. Distribution of Salmonella IgM Data

IgM *Salmonella*	n	%
Negative (-)	5	13.2
Positive (+)	33	86.8
Total	38	100.0

The examination results showed that 5 patients (13.2%) tested negative for Salmonella IgM, while 33 patients (86.8%) tested positive. Anti-Salmonella IgM is an acute-phase antibody that appears in response to Salmonella typhi infection (Betan et al., 2022). This antibody emerges as the body reacts to foreign antigens. IgM is referred to as an acute-phase antibody because it appears during the early stage of infection or while the infection is ongoing(Priskila et al., 2021). Anti-Salmonella IgM can be detected on day 5 for primary infections and on day 2 for secondary infections. When antigens enter the body, Immunoglobulin M (IgM) is the first antibody produced to combat the antigens. IgM is the most efficient and important immunoglobulin in defending against bacterial and viral infections. In primary infections, IgM levels increase first, typically between days 3–5, while IgG levels rise around day 14 (Warsyena & Wibisono, 2021).

3.3. Bivariate Analysis

Based on the statistical test results presented in the table 5, the p-value for both variables was 0.002 (p < 0.05), indicating that there is a significant relationship between neutrophil counts and Salmonella IgM results at Emanuel Hospital Banjarnegara. The correlation coefficient was 0.480,

which suggests a moderate strength of association between neutrophil counts and Salmonella IgM results.

Table 5. The Relationship Between Neutrophil Counts and Salmonella IgM

Variabel	n	*Shapiro wilk*	*Spearman*	*Correlation*
IgM *Salmonella* Neutrophil Results	38	0,00	0,002	0,480

The results of this study are consistent with the findings of Susanti & Saktiningsih (Ramaningrum et al., 2017) regarding the relationship between neutrophil counts and IgM test results in infection cases. When the body is infected by bacteria, IgM recognizes and marks the bacteria. Neutrophils then migrate to the infection site and phagocytose the bacteria tagged by IgM. This process helps the body eliminate bacteria and control the infection. IgM and neutrophils interact within the immune response to bacterial infections, where IgM aids in recognizing and tagging the bacteria, and neutrophils assist in clearing them. The roles of both components are crucial in protecting the body from bacterial infections (Rahmi, 2023)**.**

4. Conclusions

This study sheds light on the immune response in typhoid fever by providing valuable insights into the relationship between neutrophil counts and Salmonella IgM results in pediatric patients. The comprehensive analysis, framed within existing literature, contributes to the growing body of knowledge in international health, particularly regarding diagnostic evaluation in endemic areas. Our findings highlight the importance of integrating hematological and serological parameters in clinical practice to support early and accurate diagnosis. Future research should build upon these foundations through larger multicenter studies and the inclusion of additional biomarkers to further advance understanding and improve the management of typhoid fever.

Conflicts of Interest: There is no Conflict of interest

Author Contributions: AH : Conceptualize and implement research and data analysis. YEN and IAF: Evaluate and review research until it becomes a draft manuscript.

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