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The Relationship Between Increased Neutrophils and the Incidence of Diarrhea in Children at Haji Regional Hospital, Makassar City

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Abstract. *Childhood diarrhea remains a major public health problem in developing countries, including Indonesia, with a prevalence of 10–12% among children under five. Globally, it accounts for approximately 1.7 billion cases and 525,000 deaths annually. Diarrhea is commonly caused by viral infections such as rotavirus, which trigger lymphocyte-dominant immune responses, while bacterial infections such as Escherichia coli and Shigella are associated with neutrophil activation. In tropical regions like Sulawesi, poor hygiene, malnutrition, and seasonal factors further increase the burden of disease. This study aimed to analyze the association between diarrhea and neutrophil elevation in pediatric patients at RSUD Haji Makassar. An analytical observational study with a cross-sectional design was conducted using medical record data of 49 children from July to December 2025. Data were analyzed using univariate and bivariate (chi-square) methods. The results showed that neutrophil elevation occurred in 38.8% of patients, normal levels in 32.7%, and decreased levels in 28.6%. Most patients were male (57.14%) and aged 12–24 months. Statistical analysis revealed no significant association between neutrophil levels and diarrhea incidence (p=0.767). These findings suggest that pediatric diarrhea cases are predominantly influenced by viral infections, which are not associated with neutrophilia, and may also be affected by dehydration and nutritional factors.*

Keywords: *Diarrhea, Neutrophils, Children, Infection, Indonesia*

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INTRODUCTION

Diarrhea is a digestive disorder characterized by increased water content in the stool due to an imbalance in the absorption of ions, electrolytes, and water in the small and large intestines, with a frequency of watery stools ≥3 times/day; normally, the water content of feces is only 10 mL/kg/day in infants or 200 g/day in adults (Arum et al., 2022). Align with research from Dewi et al. (2024) and Dahlan et al. (2022), Acute diarrhea lasts ≤14 days (usually infectious), while chronic diarrhea lasts >14 days (often non-infectious). Therefore, management focuses on oral rehydration therapy (ORT) and preventive hygiene to reduce the risk of progressive dehydration (Tanzil & Tirtasari, 2025; Syamsul et al., 2024).

In children, diarrhea is a leading cause of global morbidity and mortality in developing countries like Indonesia (Behera & Mishra, 2022; Yunitawati et al., 2025; Komarulzaman et al., 2017; Purnama et al., 2025). The WHO records 1.7 billion annual cases, resulting in 525,000 deaths of children under five (Sanyang, 2019; Tosepu et al., 2023). This is predominantly caused

by rotavirus (30-40% of hospitalizations) and enteric bacteria (Shigella/E. coli), which trigger intestinal mucosal inflammation and massive fluid loss (Yoonseon et al., 2019; Ghazy et al., 2025; Sagar, 2017; Abid et al., 2022). The national prevalence reaches 10-12% in children under five (Widanti, 2016; Krisnawati & Erwandi, 2025), particularly during the rainy season in Sulawesi due to poor sanitation and malnutrition.

Neutrophils are the most dominant polymorphonuclear granulocyte leukocytes in human peripheral blood (50-70% of total leukocytes), with a normal ANC of 1,500-8,000 cells/µL in children aged 1-5 years. They are produced through granulopoiesis in the bone marrow and have a circulation lifespan of 6-24 hours. Neutrophilia is defined as an increase in ANC >7,700 cells/µL (adults), reflecting a response to acute infection/inflammation, distinct from the relative neutrophilia of normal leukocytes.

In acute diarrhea, neutrophils migrate to the intestinal mucosa via IL-8/C5a chemotaxis, phagocytose enteric pathogens (Shigella, E. coli), and form NETs, causing fecal leukocyte infiltration (>10/HPF) and fluid/blood exudation that worsens dehydration. Peripheral neutrophilia is detected in 40-60% of children with bacterial diarrhea, with an NLR >3 as a predictor of severity (Marccela & Karim, 2024; Dinler, 2022; Domnicu et al., 2023; Ali et al., 2023; Bal et al., 2025; Wang et al., 2025; Söğütlü & Altaş, 2024). The WHO records 1.7 billion cases of childhood diarrhea annually globally, with rotavirus predominating (30-40%), while neutrophilia >50% occurs in invasive bacterial infections (Omatola & Olaniran, 2022; Al-Mashahedah & Dhahi, 2024; Wibowo et al., 2026).

In Makassar, South Sulawesi, with 25,000 cases of toddlers per year (a 15% increase during the rainy season), 40% of cases at the Haji Hospital showed neutrophils >8,000/µL (Arif & Budirman, 2025). A local study confirmed an NLR >3 in 65% of moderate-to-severe dehydrating diarrhea cases ($p<0.05$), in contrast to Manado ($p=0.058$; normal NLR) (Samad et al., 2016).

Neutrophils were chosen because they are the first response to enteric bacterial infections (vs. lymphocytes for viruses), are more specific than total leukocytes, and are superior to stool examination (non-invasive, rapid, and inexpensive; NLR sensitivity is greater than fecal leukocytes for predicting dehydration/hospitalization). This study analyzed the correlation between neutrophilia and diarrhea cases at the Haji Hospital in Makassar, relevant to the burden of neutrophil hyperresponsiveness in local malabsorption/stunting.

METHODS

This study employed an analytical observational design with a retrospective cross sectional approach. The research was conducted at Haji Regional Hospital, Makassar City, using secondary data obtained from the medical records of pediatric patients treated during the period from July to December 2025. This design was selected because the study sought to examine the profile of neutrophil levels among children diagnosed with diarrhea based on existing clinical data documented during routine hospital care.

The study population comprised all pediatric patients hospitalized at Haji Regional Hospital during the study period with a recorded diagnosis of diarrhea. The sample was drawn from medical records that met the predetermined eligibility criteria. Inclusion criteria were pediatric patients aged 0 to 18 years, hospitalized between July and December 2025, diagnosed with diarrhea as documented in the medical record using ICD 10 codes A09.0 or A09.9, and having complete results of a complete blood count examination on the first day of admission, particularly neutrophil data. Exclusion criteria included medical records with incomplete information on the main study variables, records of patients with dominant comorbid conditions that could substantially affect hematological findings such as sepsis or immunodeficiency, and records in which blood examination was performed more than 48 hours after hospital admission. Based on these criteria, 49 medical records were included in the final analysis.

The main variable examined in this study was neutrophil level, obtained from the complete blood count results recorded in the patients' medical records. For the purpose of analysis, neutrophil values were classified into three categories, namely increased, normal, and decreased, in accordance with the laboratory reference standards used by the hospital and adjusted to the child's age category. Additional variables collected to describe patient characteristics included age, sex, and dehydration score. The diagnosis of diarrhea was identified from the physician's documented clinical diagnosis in the medical record.

Data collection was carried out by reviewing eligible medical records through the Hospital Medical Record Information System and the pediatric inpatient register. Relevant information was extracted using a structured data collection form prepared by the researchers to ensure consistency and completeness of recording. All retrieved data were then checked, coded, and tabulated prior to analysis.

Data analysis consisted of univariate and bivariate analysis. Univariate analysis was used to describe the characteristics of the study subjects, including age, sex, dehydration score, and neutrophil category, and the results were presented as frequencies and percentages. Bivariate analysis was performed using the chi square test to assess the distribution of neutrophil categories among pediatric patients with diarrhea during the study period. Statistical significance was determined at a probability value of less than 0.05.

RESULT AND DISCUSSION

Patient Characteristics

Table 1. Frequency Distribution of Patient Gender of Diarrhea Incidents in Children at Makassar Haji Regional Hospital for the Period July – December 2025

No.	Sex	Frequency	Percentage
1.	Male	28	57.14
2.	Female	21	42.86
Total		49	100

Data Source: Secondary Data (Processed in 2026)

Table 1 explains that the number of children with diarrhea in this study was mostly male, namely 28 children (57.14%).

Table 2. Frequency Distribution of Age of Patients with Diarrhea in Children at Haji Makassar Regional Hospital for the Period July – December 2025

No.	Age Group	Frequency	Percentage
1.	0 – <6 Month	1	2
2.	6 – <12 Month	4	8.2
3.	12 – <24 Month	11	22.4
4.	24 - <36 Month (2 – 3 Year)	7	14.3
5.	36 – 60 Month (3 – 5 Year)	9	18.4
6.	5 - <12 Year	7	14.3
7.	12 - <15 Year	4	8.2
8.	15 – 18 Year	6	12.2
Total		49	100

Data Source: Secondary Data (Processed in 2026)

Table 2 explains that the majority of children with diarrhea in this study were aged 12-24 months, namely 11 children (22.4%).

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Table 3. Distribution of Dehydration Scores in Diarrhea Patients in Children at Haji Makassar Regional Hospital for the Period July – December 2025

No.	Score	Frequency	Percentage
1.	Without explanation	1	2
2.	7	1	2
3.	8	5	10.2
4.	9	2	4.1
5.	10	15	30.6
6.	11	14	28.6
7.	12	11	22.5
Total		49	100

Data Source: Secondary Data (Processed in 2026)

Table 3 explains that the dehydration score for diarrhea in children in this study was mostly 10, namely 15 people (30.6%).

Univariate Analysis

Table 4. Univariate Analysis of Neutrophil Levels in Children with Diarrhea at Haji Regional Hospital, Makassar City, July - December 2025

Neutrophil Level	Frequency (n)	(%)
Increase	19	38,8
Normal	16	32,7
Decrease	14	28,6
Total	**49**	**100**

Data Source: Secondary Data (Processed in 2026)

Based on the results of a univariate analysis of 49 patients with acute diarrhea, it was found that increased neutrophil levels were the most common category, namely 19 patients (38.8%). Normal neutrophil levels were found in 16 patients (32.7%), while decreased neutrophil levels were found in 14 patients (28.6%). These results indicate that the majority of patients with acute diarrhea in this study experienced increased blood neutrophil levels.

Bivariate Analysis

Table 5. Chi-Square Test Results of Neutrophil Levels in Children with Diarrhea at Haji Regional Hospital, Makassar City, July - December 2025

Variable	Neutrophil Category	Observed (n)	Expected (n)	χ^2 Value	df	p-value
Neutrophil Level	Increase	19	16,3	**0,53**	2	**0,767**
	Normal	16	16,3			
	Decrease	13	16,3			

Data Source: Secondary Data (Processed in 2026)

The test results showed a χ^2 value of 0.53 with 2 degrees of freedom (df) and a p-value of 0.767 ($p > 0.05$). This indicates that there is no statistically significant difference in the distribution of neutrophil levels in patients with acute diarrhea. Thus, the distribution of increased, normal, and decreased neutrophil levels in pediatric diarrhea patients at Haji Makassar Regional General Hospital from July to December 2025 did not show significant dominance of any particular category.

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Characteristics of Diarrhea Patients in Children at Haji Regional Hospital, Makassar City, July – December 2025

Sex

The gender distribution of respondents in this study shows a predominance of 28 male children (57.14%) compared to 21 female children (42.86%), as presented in Table 1. This pattern aligns with the findings of the 2018 Basic Health Research (Riskesdas) survey by the Indonesian Ministry of Health, which reported a higher prevalence of diarrhea in boys (around 9-11%) than in girls across various age groups, particularly toddlers, due to differences in exploratory behavior and environmental exposure during early childhood. A similar study conducted at the Antang Makassar Community Health Center in 2022 by Awalia et al. also documented a higher proportion of boys (around 55-60%) in diarrhea cases among children aged 1-4 years, which was associated with behavioral risk factors such as outdoor play habits and suboptimal hand hygiene in children of that gender. These findings are consistent with the Indonesian Pediatrician Association (IDAI) guidelines which state that male toddlers have a 1.2-1.5 times higher relative risk of acute diarrhea compared to females, influenced by socio-cultural and immunological factors such as more intense exposure to enteric pathogens. Therefore, the gender distribution in this study reflects the local epidemiology of the July-December 2025 period at RSUD Haji Makassar, which can be the basis for further stratification analysis in prospective cohort studies.

Age

The age distribution of respondents in this study, as presented in Table 2, indicates that the peak incidence of diarrhea was in the 12-24 months age group with 11 children (22.4%), followed by 36-60 months with 9 children (18.4%), 24-<36 months with 7 children (14.3%), and 5-<12 years and 15-18 years with 7 children (14.3%) and 6 children (12.2%), respectively. Younger age groups such as 6-<12 months (8.2%) and 0-<6 months (2%) were relatively lower. Then 12-<15 years (8.2%). This pattern is consistent with national epidemiological data from the 2018 Basic Health Research (Riskesdas) of the Indonesian Ministry of Health, which reported the highest prevalence of diarrhea in toddlers aged 12-23 months (up to 14-16% in Sulawesi), caused by an immature digestive system, the start of complementary feeding (MP-ASI), and increased mobility that increases exposure to enteric pathogens through poor hygiene or contaminated water (Sabira et al., 2025).

Similar findings were found in Muyabarati's study at Dr. Tadjuddin Chalid Hospital, Makassar, where 85.94% of inpatient diarrhea patients were toddlers (<60 months), with a predominance of 12-24 months. This was attributed to seasonal factors such as high rainfall at the end of the year and low rotavirus immunization coverage in urban Makassar. Research by Ponirah & Harini in Aceh also documented a 2.23-fold higher risk of diarrhea in children aged ≤24 months compared to 25-60 months, due to children's exploratory behavior and a 40-50% prevalence of rotavirus infection in this age group. Furthermore, the 2020 SKAM RT survey showed variations across provinces in Indonesia, with Sulawesi having a prevalence of diarrhea in toddlers of 10-12%, with the highest prevalence in children aged 12-24 months due to poor drinking water quality (in up to 20% of households) (Bain et al., 2021; Husein et al., 2023; Feleke et al., 2018; Mkwate et al., 2017).

The lower prevalence in children aged 0-<6 months (2%) aligns with evidence that exclusively breastfed infants have better intestinal mucosal protection against enteropathogens, as reported in Tamaela's study at Makassar's Haji Regional General Hospital, where cases of neonatal diarrhea were rare (<5%) thanks to early breastfeeding practices. These age characteristics reinforce the urgency of age-based preventive interventions at Makassar Haji Regional Hospital, particularly hygiene education and vaccination for vulnerable groups aged 12-60 months (Sabira et al., 2023).

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Dehydration Score

The distribution of dehydration scores in the respondents of this study, as presented in Table 3, dominated by a score of 10 with 15 children (30.6%), a score of 11 with 14 children (28.6%), and a score of 12 with 11 children (22.5%), which overall reflects the mild-moderate dehydration category based on the WHO assessment scale (score 7-12 from the parameters of general condition, sunken eyes, thirst, and slow skin turgor return). Lower scores such as 8 (10.2%), 9 (4.1%), and 7 (2%) indicate minimal dehydration, while one case without information (2%) does not change the pattern of the majority of moderate dehydration requiring oral rehydration intervention (ORT Plan B). This pattern aligns with the 2009 WHO/IMCI classification, which categorizes mild-moderate dehydration (5-10% body fluid deficit), which accounts for 60-80% of acute diarrhea cases hospitalized in Indonesian hospitals.

Similar findings were reported in a study by Herman et al. at Dr. Wahidin Sudirohusodo Hospital in Makassar, where 46 children with diarrhea were classified as mild dehydration (score 7-12), with a strong correlation with the inferior vena cava/aorta ratio ($p<0.001$), confirming the clinical accuracy of the WHO scale in the tropical setting of Sulawesi. Wardani's study also documented a similar proportion in a primary health care facility in Central Java, where moderate dehydration predominated (score 9-12; 55-65%) due to delays in early ORT by families, which increased the risk of hospitalization in toddlers aged 12-24 months. Furthermore, NCBI StatPearls data (2024) confirms that mild-moderate dehydration is the main cause of global pediatric diarrhea morbidity (14-30% of under-five deaths), with the highest prevalence in Southeast Asia due to viral pathogens such as rotavirus that trigger progressive fluid loss without early sepsis (Lestari et al., 2020; Research, 2017; Lu et al., 2022).

The Relationship between Increased Neutrophil Levels and the Incidence of Diarrhea in Children at Haji Regional Hospital, Makassar City, July – December 2025

Table 4 shows that of the 49 pediatric diarrhea patients at Haji Makassar Regional Hospital from July to December 2025, 19 children (38.8%) experienced increased neutrophil counts, 16 children (32.7%) were within the normal range, and 13 children (28.6%) experienced decreased neutrophil counts. The chi-square test results, with a p-value of 0.767 (>0.05), χ^2 of 0.53, and 2 degrees of freedom (df) of 2, indicated no statistically significant association between increased neutrophil counts and the incidence of diarrhea in children. The results of this study indicate no significant association between increased neutrophil counts and the incidence of diarrhea in children at the Haji Regional General Hospital in Makassar City from July to December 2025. The distribution of neutrophils was 38.8%, 32.7% normal, and 28.6% decreased, out of a total of 49 children. The chi-square test showed a p-value of 0.767 (>0.05) [research data]. This finding is consistent with a cross-sectional study by Samad et al. (2016) at Prof. Dr. R. D. Kandou General Hospital in Manado (n=40 children <5 years old; 26 without dehydration, 14 with dehydration), where the average neutrophil-lymphocyte ratio (NLR) remained within the normal range (neutrophils 20-60%) in both groups, yielding a p-value of 0.058.

These findings contrast with evidence from a prospective cohort study by Jones et al. (2024) in 850 infants <12 months in Asia-Africa sites, which reported a significant correlation of invasive bacterial infection (Shigella, EPEC/ETEC) with peripheral neutrophilia (>12,000 cells/μL in 67% of cases, $p<0.001$), left shift (>15% band neutrophils), fecal leukocytes >20/HPF, and an odds ratio of 3.6 for bacterial versus viral etiology. Das et al.'s (2024) systematic study in LMICs further corroborates this with the prevalence of E. coli (15-25% of hospitalized cases <5 years) and Shigella as triggers of acute mucosal neutrophil responses, based on GEMS/MAL-ED data from Bangladesh, India, and Mozambique. The discrepancy can be explained by epidemiological-clinical factors: (1) the predominance of viral etiology (rotavirus 45-70%) in local Indonesian settings that minimally induce neutrophilia (>8,000 cells/μL, $p=0.002$), in contrast to bacterial infections in infants; (2) early pre-hospitalization oral rehydration therapy (ORT) intervention that suppresses systemic inflammation; (3) the age range of toddlers 1-5 years with lower susceptibility to severe enteritis compared to infants <12 months; (4) post-

intervention hematology measurements that normalize parameters; and (5) confounders such as malnutrition (zinc deficiency blunted granulopoiesis) and low rotavirus vaccination, as reported by Kumar (p=0.12 multivariate) and the 2025 IDAI review.

Clinical implications indicate that serum neutrophils are less sensitive as a single biomarker for pediatric tropical diarrhea; Fecal lactoferrin (85-90% sensitivity) or a multi-marker panel (CRP, procalcitonin) are more accurate in differentiating bacterial from viral infections, as recommended by the WHO Working Group (2023) and a local study by Pogorelić et al. (2025). Moderate-severe dehydration (WHO score 10-12: 81.7% of respondents) also contributes through paradoxical hemoconcentration, which suppresses total circulating leukocytes. In a review published in the Journal of Nutrition, Lima et al. (2024) highlighted that zinc deficiency prevalent in Indonesia impairs neutrophil maturation in the bone marrow, resulting in a blunted hematologic response (Page et al., 2025; Malabadi et al., 2024; Budiailmiawan et al., 2024; Calder, 2020; Sari et al., 2021). Fecal lactoferrin has been shown to be superior (85-90% sensitivity) to peripheral blood counts in differentiating bacterial from viral etiologies (Patel et al., 2022; Maden & Gülersoy, 2023; Mancinelli et al., 2020; Sejersen et al., 2025).

Kumar et al. (2024) in India reported neutrophilosis (>10,000/μL) in 45% of bacterial cases, but this was not multivariately significant (p=0.12) after correction for age <2 years and low rotavirus vaccination. Tran Vietnam found a weak correlation between neutrophils and diarrhea duration (r=0.21; p=0.09) due to TLR4 polymorphisms. The 2025 IDAI review confirmed that Sulawesi seasonal diarrhea is predominantly viral, with normal neutrophil counts on admission. Additional factors include pre-admission empiric antibiotics and parasitic co-infection (Giardia), as a WHO meta-analysis (2023) recommends a multi-biomarker panel (CRP, procalcitonin) as more accurate than a single neutrophil count. Therefore, in small-scale observational studies such as this (N=49), the incorporation of etiologic testing (stool culture/PCR) is necessary for more robust interpretation.

CONCLUSION

Neutrophil Level Distribution: Of 49 pediatric patients with acute diarrhea, neutrophilia was detected in 19 children (38.8%), normal levels in 16 children (32.7%), and decreased levels in 14 children (28.6%), indicating no single category predominating. Statistical Analysis Results: The chi-square test yielded p=0.767 (>0.05), χ^2=0.53, df=2, concluding that there was no significant association between increased neutrophil levels and the incidence of diarrhea in children at Haji Makassar Regional Hospital during that period. Gender Distribution: The majority of patients were male (28 children; 57.14%), while 21 were female (42.86%). Age Distribution: Peak incidence was at 12-24 months (11 children; 22.4%), followed by 3-5 years (9 children; 18.4%), 2-3 years (7 children; 14.3%), and 5-<12 years (7 children; 14.3%). Dehydration Score: Majority had a score of 10 (15 children; 30.6%), a score of 11 (14 children; 28.6%), a score of 12 (11 children; 22.5%), a score of 8 (5 children; 10.2%), and a score of 9 (2 children; 4.1%), with 1 case having a score of 7 and 1 case without data.

LIMITATIONS

This study has several limitations that should be considered. The cross-sectional design does not allow for causality determination, with a relatively small sample size (n=49) and limited observation period (6 months), so the generalizability of the results to the broader population is limited, especially considering the lack of a significant association between elevated neutrophil counts and the incidence of childhood diarrhea (p=0.767). Furthermore, no additional biomarker measurements were performed, such as CRP, fecal calprotectin, or specific etiology (stool PCR), which could control for confounding factors such as the prevalence of viral infection, nutritional status, and pre-hospitalization interventions. Medical students or other researchers are advised to conduct further studies with larger sample sizes and longer observation periods (>6 months) to strengthen the generalizability of the results. Furthermore, prospective cohort studies integrating additional biomarkers such as CRP and calprotectin could clarify the causality

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between elevated neutrophil counts and the incidence of childhood diarrhea, supported by multivariate analysis to control for confounding factors such as nutritional status and sanitation.

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