



Original Research Paper

Analysis of Hematological Response to Stress: Study of Leukocyte Number and Erythrocyte sedimentation rate in Setia Budi University Students

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Abstract

Background: Stress is a psychological condition that has the potential to affect the immune system, including the leukocyte count and erythrocyte sedimentation rate. Various reasons might induce stress in female students, including physical ailments, interpersonal interactions, academic pressures, and environmental conditions. **Objective:** This study aims to analyze the difference in leukocyte count and erythrocyte sedimentation rate in female students with different stress levels at the Faculty of Health Sciences, Setia Budi University. **Methods:** This study was an observational quantitative research with a cross-sectional approach which was carried out in October 2024-April 2025 with a total of 68 female students selected by purposive sampling. Stress measurement using Student Stress Inventory questionnaires. Leukocyte count was calculated using a hematology analyzer, and erythrocyte sedimentation rate was examined using the Westergren method on EDTA venous blood samples. **Results:** The data was analysed with Independent-t Test. The analysis's findings demonstrated that the high-stress group had more leukocytes than the low-stress group ($p=0.004$). The high-stress group had a higher erythrocyte sedimentation rate than the low-stress group ($p=0.001$). **Conclusion:** There is a significant difference in leukocyte count and the erythrocyte sedimentation rate between female students with different levels of stress.

Keywords: Stress; Leukocyte Count; Erythrocyte Sedimentation Rate; Female Student.

Introduction

Rigorous academic pressures, such as assignments, tests, and demands to perform often plague college students. Stress is also a common phenomenon that occurs in academic settings. More than 350 million people around the world are feeling stressed in 2023. Studies show that 36.7% to 71.6% of students feel stressed during higher education. Stress is a major factor that can affect students' physical and mental health¹.

Psychoneuroimmunological studies show that psychological elements can affect the functioning of the body's immune system and

overall physical health, and vice versa. Stress can trigger inflammation in the body which has an impact on immunity which can be seen from changes in the number of leukocytes. In the study conducted by Alhmoud, the examination of blood samples from students in the third year of college showed a significant increase in the number of neutrophils ($p<0.05$)². Students with academic stress, in addition to experiencing inflammation marked by changes in the number of leukocytes, were also followed by an increase in the rate of blood precipitation³.

Stress is a physiological response to the existence of a pressure or challenge that is considered to exceed the limits of an

individual's ability^{3,4}. Stress in college students can be caused by several things such as exam-related pressure, high academic standards, and lack of social support^{3,5,6}. Impact from the academic side, a person who experiences stress cenderung mengalami penurunan prestasi, attendance rate, and concentration during lectures. One of the measurement tools that can be used to assess a person's stress level is the *Student Stress Inventory* (SSI) questionnaire. This questionnaire assesses a person's stress level based on several things, namely physical stress, interpersonal, academic, and environmental relationships⁷.

The immune system of the human body is classified into two types, namely innate immunity and adaptive immunity⁸. Innate immunity is the body's first defense of non-specific, while adaptive immunity provides a slow but more specific response to certain types of pathogens⁸. In addition to being affected by stress, the immune system is also affected by several hormones such as increased cortisol and cytokines⁹⁻¹¹.

Leukocytes or white blood cells are part of the body's defense system that has a role in providing an inflammatory response, fighting infection and disease through phagocytosis^{2,12}. There are several types of leukocytes which are neutrophils, eosinophils, basophils, lymphocytes, as well as¹³ monocytes. Normal values of leukocytes range from 5,000 to 10,000 cells/mm³¹⁴. In addition to changes in the number of leukocytes, the occurrence of inflammation can also be seen through an examination (ESR)¹⁵. It is an examination of the rate of erythrocyte deposition at the bottom of the tube in a certain time and expressed in millimeters per hour (mm/h)¹⁶.

The blood precipitation rate in females ranges from 0-20 mm/h while in males it is 0-15 mm/h¹⁷. This difference in value range is because women have higher estrogen hormones than 18-year-old men^{>18}. In</sup>

addition, hemoglobin levels, which tend to be lower in women compared to men, also affect the results of erythrocyte sedimentation rate¹⁹. Both of these examination parameters are important because they provide a clear picture of a person's immune condition.

The purpose of the study was to examine the differences in the number of leukocytes and erythrocyte sedimentation rates based on different stress levels of Setia Budi University students. The vision of the study is aligned with the hypothesis that there is a difference in the number of leukocytes and the rate of blood precipitation in female students with different levels of stress.

The urgency of this study is considering the number of students who experience decreased achievement, concentration, and physical disturbances when they are in stressful conditions. Therefore, scientific evidence is needed on how stress affects the immune system of college students through examination of hematological parameters.

Materials and Methods

Study Design

This study included a quantitative observational study along with a cross-sectional design to distinguish the number of leukocytes and the rate of precipitation in female students with different levels of stress. This design was chosen because it was able to see the average difference between stress groups at one time, so that data collection could be carried out in one hematology examination (leukocyte count and erythrocyte sedimentation rate).

Sample

The study population is students of the Faculty of Health Sciences, Setia Budi University. The study sample was determined using a *purposive sampling* design along with inclusion indicators, namely female students aged 18-25

years in good health and the exclusion criteria were fever, menstruation, taking supplements/medicines, hospitalized in the last 3 months, and donating/receiving blood transfusions in the last 3 months. The number of samples was determined based on the *Slovin* formula because the population was < 1000 people, so that in this study 68 respondents²⁰.

Data Collection Technique

Data collection used the Student Stress Inventory (SSI) questionnaire to measure stress levels, check the number of leukocytes with the Hematology Analyzer, and ESR examination using the Westergren method which has been tested for validity and reliability if using research instruments. The stress group is divided into two, namely the group with low stress levels (SSI score < 80) and the group with high stress levels (SSI > 80). Hematology Analyzer applies several principles such as electrical impedance, optical method, and flowcytometry²¹. The Westergren method was chosen because of its stable and consistent results so that it can be recommended (ICSH)²². The data collection procedure was carried out at Setia Budi University and sample examination at the Surakarta Regional Health Laboratory within a period of 2 months.

Data Analysis Technique

The information is put together descriptively to find out the mean±SD, minimum value, and maximum value. Followed by a normality test using the Kolmogorov-Smirnov method, where the data with the criteria are normally distributed if $p > 0.005$ ²⁰. The difference in the average number of leukocytes and ESR values of the two groups was tested with the Independent-t Test. The results are significant if $p < 0.05$ becomes the study hypothesis accepted. The analysis was carried out with the help of SPSS Statistics 25 to ensure the accuracy of the results.

Ethical Consideration

The study has obtained ethical clearance approval from the Ethics Committee of the Faculty of Medicine, Sebelas Maret University along with No: 33/UN27.06.11/KEP/EC/2025. All participants were given Informed Consent prior to participating in the study, and the data collected was guaranteed to be confidential in accordance with the ethical principles of health research.

Results

It can be studied in table 1. In this study, there were 68 female students of Setia Budi University along with an age range of 18-25 years. All respondents were women because they were more susceptible to stress than men due to psychological and hormonal factors²³. All respondents are in good health and have complied with the set criteria.

Table 1. Respondent Characteristics

Variable	Group	Frequency (n)	Percentage (%)
Age (year)	18-25	68	100%
	>25		
Fever	Yes	68	100%
	No		
Menstruation	Yes	68	100%
	No		
Supplements	Yes	68	100%
	No		
Recording	Yes	68	100%
	No		
Transfusion	Yes	68	100%
	No		

Source : Primary Data 2025

This study involved 68 participants, who were categorized into two groups based on their stress levels: a low-stress group (n = 35) and a high-stress group (n = 33). The classification was performed using the predetermined stress assessment criteria. Baseline characteristics of the participants were analyzed to provide an overview of the study population before further statistical analysis. Descriptive statistics were calculated for all study variables, including

stress levels, leukocyte counts, and erythrocyte sedimentation rates (ESR). These data summarize the distribution and central tendency of each variable and provide an initial comparison between the two groups. The descriptive findings are presented in Tables 2, 3, and 4, which illustrate the characteristics of the participants and the observed hematological parameters prior to inferential analysis.

Table 2. Descriptive Overview of Stress Levels, Leukocyte Counts, and ESR

Variable	N	Mean ± SD	Min - Max
Stress Level	68	79,16 ± 18,1	41,00 - 123,00
Leukocyte	68	7,41 ± 1,88	4,00 - 15,80
ESR	68	19,85 ± 7,15	6,00 - 42,00

Sumber : Data Primer 2025

Table 2 depicts the average stress score of 79.16 with a minimum score of 40 and a maximum of 123. The average number of leukocytes of the participants was 7.41 x 10³ cells/mm³ with a value distribution of 4.00-15.80 x 10³ cells/mm³. The average ESR score of all participants was 19.85 mm/h with a minimum value of 6.00 mm/hour and a maximum value of 42.00 mm/hour.

The division or distribution of stress groups based on physical stress, interpersonal, academic, and environmental relationships can be seen in table 3 such as:

Table 3. Distribution of Groups by Stress Level by Physical Stress, Interpersonal, Academic, and Environmental Relationships

Variable	Low Stress (SSI<80)	High Stress (SSI>80)
Physical	24%	24%
Interpersonal	22%	21%
Academic	26%	27%
Environment	28%	28%
Total	100%	100%

Source : Primary Data 2025

The table above illustrates the group with a dominant low level of stress due to environmental stress (28%), academic stress 26%, physical stress 24%, and stress due to

interpersonal relationships worth 22%. Meanwhile, in the group with high levels of stress, the dominant was caused by environmental stress worth 28%, academic stress 27%, physical stress 24%, and interpersonal relationship stress 21%.

The comparison between the average number of leukocytes and ESR is shown in table 4

Table 4. Comparison of Average Leukocyte Count and ESR

Variable	Low Stress (SSI<80)	High Stress (SSI>80)	P
Leukocytes (x 10 ³ sel/mm ³)	6,78±1,26	8,09±5,76	0,004*
ESR (mm/jam)	15,62±2,19	24,33±5,62	0,001*

Note: p<0.05 shows a significant association

Source : Primary Data 2025

It can be observed that there is a difference in the average of the two examination parameters. The low-stress group had an average leukocyte count of 6.78 x 10³ cells/mm³, while the high-stress group had an average total of 8.09 x 10³ cells/mm³. ESR values in the low stress group were 15.62 mm/h and the high stress group were 24.33 mm/h. Illustrating that there is an increase in the number of leukocytes and ESR in line with stress levels. The results of the test differ using the Independent-t Test method. The average leukocyte counts showed significant differences in the low and high stress groups (p=0.004). Similarly, the ESR results differed significantly between the two groups (p=0.001). The findings support the hypothesis that the level of stress that occurs in female students is related to changes in hematological parameters, namely the leukocyte counts and the rate of blood precipitation.

Discussion

The characteristics of the respondents selected in this study certainly have a great influence on

the results of the study. A total of 68 respondents with an age range of 18-25 years reflect the group of early adults who are prone to experiencing stress²⁴. Biologically, women have more sensitive hormonal conditions so they are prone to stress²³. Psychoneuroimmunological theories state that emotional stress can activate the autonomic nervous system, increase the hormone cortisol by activating the hypothalamic-pituitary-adrenal axis (HPA-axis), as well as stimulate the release of pro-inflammatory cytokines²⁵. This increase in the hormone cortisol leads to the redistribution of leukocytes into the bloodstream with an increase in the number of neutrophils^{8,26}. An increase in the leukocyte counts biologically through the stimulation of cortisol and adrenaline also accelerates the release of leukocytes from the bone marrow to blood circulation²⁷.

Based on the results of the above study, it can be seen that the group with high levels of stress has a higher leukocyte counts and blood deposits rate than the group with low stress levels. The difference was statistically significant, namely $p=0.004$ for the leukocyte counts and $p=0.001$ for the ESR value. This study is in line with the study of Chaudhuri & Banerjee (2018) which proved that there was a significant increase in the leukocyte counts of respondents with a stress level of >200 compared to a stress level of <200 ¹⁰. Meanwhile, based on research conducted by Shawesh *et al.*, (2020), there was no significant difference in the examination of the leukocyte counts in the period before the exam or during the exam period³.

The main mechanism of increasing the ESR value is the acceleration of the formation of rouleaux due to increased levels of fibrinogen and globulin plasma as acute phase proteins, so that erythrocyte sedimentation occurs faster²⁸. An increase in the score (ESR) in the high-stress group is consistent with a

study conducted by Tan *et al.*, (2023) illustrating that stress in the absence of infection can increase the rate of blood precipitation²⁹. Another study carried out by Prasertsri *et al.*, (2019) said that excessive physical activity can increase ESR and the leukocyte counts as a temporary inflammatory response³⁰.

The clinical implication of this study is the importance of early detection of stress in female students because changes in the leukocyte counts and erythrocyte sedimentation rate values can reflect an inflammatory response, which has the potential to lower the immune system's immunity, which can affect academic performance and health if not handled properly.

The advantage of the study lies in the use of questionnaires, namely Student Stress Inventory (SSI). This questionnaire can specifically assess the stress aspects of physical, interpersonal, academic, and environmental relationships. The selection of laboratory test parameters including the leukocyte counts and ESR also supports valid and reliable results. But the study still has limited sample limits in the female population so it does not reflect the condition of the male population, while stress can hit both women and men.

For further research, it is recommended to use other laboratory parameters that can measure inflammation and related hormones such as cortisol and cytokines. Research with a wider and more diverse population, such as male students or different age ranges, can be conducted to get a more representative picture.

Conclusion

The study illustrates that there are significant differences in the leukocyte counts and ESR of female students along with different levels of stress. The group with high stress levels had an average leukocyte counts and ESR $>$ the low-

stress group. It is necessary to make stress management efforts for students through counseling, regular exercise, and maintaining a healthy lifestyle so that stress does not have a negative impact physically and academically. For future studies, there are suggestions to enrich the total participants and come from various backgrounds so that wider results are obtained.

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References

1. Yuda MP, Mawarti I, Mutmainnah M. Gambaran tingkat stres akademik mahasiswa dalam menyelesaikan tugas akhir skripsi di fakultas kedokteran dan ilmu kesehatan universitas jambi. *Pinang Masak Nurs J.* 2023;2(1):38-42.
2. Alhmoud JF, Farah HS, Al-Qaisi T, et al. The changes in some hematological parameters among university students due to stressful conditions during and after examinations period. *Indian J Forensic Med Toxicol.* 2021;15(1):1181-1186. doi:10.37506/ijfmt.v15i1.13578
3. Shawesh F, Khdeir A, Alzaruge R, Abu-Alqasim M, Kharbash A, Elazomi A. Effect of examination stress on blood cells parameters among medical technology students in the university of zawia, libya. *Eur J Pharm Med Res.* 2020;7(1):171-176.
4. Sitepu JN. Hubungan Tingkat Stress, Kualitas Tidur, Dan Prestasi Akademik Mahasiswa Fakultas Kedokteran Universitas Hkbp Nommensen. *Heal Tadulako J (Jurnal Kesehatan Tadulako).* 2024;10(3):336-342. doi:10.22487/htj.v10i3.1129
5. Sheikh R, Riaz U, Leeza S. Assessing physiological responses: exam stress and leukocyte count in medical students at PUMHSW, nawabshah. *Pakistan J Med Dent.* 2024;13(1):75-80. doi:10.36283/pjmd13-1/014
6. Perkasa T, Jaya MA, Namirah HA, Amaliyah IK. Description of The Degree of Stress , Anxiety and Depression in Teachers at Wahdah Islamic School 03 Makassar. *Heal Tadulako J (Jurnal Kesehatan Tadulako).* 2025;11(3):361-369.
7. Arip MASM, Kamaruzaman DN, Roslan A, Ahmad A. Student stress inventory (SSI). Published online 2020.
8. Darwin E, Elvira D, Elfi EF. *Imunologi Dan Infeksi.* Andalas University Press; 2021.
9. Maydych V, Claus M, Dychus N, et al. Impact of chronic and acute academic stress on lymphocyte subsets and monocyte function. *Public Libr Sci ONE.* Published online 2017:1-19. doi:10.1371/journal.pone.0188108
10. Chaudhuri A, Banerjee D. Impact of perceived stress on white blood cell count, erythrocyte sedimentation rate and lipid profile among first MBBS students in a medical college of west bengal. *Int J Res Rev.* 2018;5(12):11.
11. Fadrian F, Ahmad A, Harvindra A, Putri VY. Different Sepsis Patient Outcomes Due to Multidrug-Resistant Organisms (MDRO): A Study of Empirical Antibiotic Sensitivity Test Results. *Heal Tadulako J.* 2025;11(3):462-479.
12. Azimata R. Perbedaan jumlah leukosit pada darah edta segar dan darah edta yang ditunda selama 2 jam. *J Ilmu Keperawatan (Journal Nurs Sci.* 2024;13:120-130.
13. Bodzas A, Kodytek P, Zidek J. A high-resolution large-scale dataset of pathological and normal white blood cells. *Sci Data.* 2023;10(1):1-5. doi:10.1038/s41597-023-02378-7
14. Saadah S. *Sistem Peredaran Darah Manusia.*; 2018.
15. Queiro R, Alonso S, Burger S, et al. Tailoring Inflammatory Biomarker Assessment in Axial Spondyloarthritis: A Comparative Study of Erythrocyte Sedimentation Rate and C-Reactive

- Protein Across Disease Profiles. *J Pers Med.* 2025;15(8):329. doi:10.3390/jpm15080329
16. Riana ARD, Durachim A, Hayati E, Marlina N. Pengaruh suhu ruangan dan lama simpan darah sitrat terhadap nilai laju endap darah metode westergren. *J Kesehatan Siliwangi.* 2023;4(1):300-307. doi:10.34011/jks.v4i1.1493
17. Rahmawati C, Aini, Ramadanti. Pengaruh dosis antikoagulan edta 10% dan natrium sitrat 3,8% pada pemeriksaan laju endap darah. *J Penelit dan Kaji Ilm Kesehat.* 2019;5(1):79-85.
18. Zhbanov A, Yang S. Effects of aggregation on blood sedimentation and conductivity. *Public Libr Sci ONE.* 2015;10(6):1-25. doi:10.1371/journal.pone.0129337
19. Alende-Castro V, Alonso-Sampedro M, Vazquez-Temprano N, et al. Factors influencing erythrocyte sedimentation rate in adults. *Medicine (Baltimore).* 2019;98(34):e16816. doi:10.1097/md.00000000000016816
20. Zulfikar R, Sari FP, Fatmayati A, et al. *Metode Penelitian Kuantitatif.*; 2024.
21. Doi H, Matsuura H, Akiyama H, Ito H. Deviation in white blood cell count measurement between wnr and wdf channels on an automated hematology analyzer xn-3000: a case report. *South East Eur J Immunol.* 2023;7:1-6. doi:10.3889/seejim.2024.6059
22. Firdayanti, Umar A, Susanti, et al. *Dasar-Dasar Hematologi.* 1st ed. Eureka Media Aksara; 2024.
23. Mengelkoch S, Slavich GM. Sex differences in stress susceptibility as a key mechanism underlying depression risk. *Curr Psychiatry Rep.* 2024;26(4):157-165. doi:10.1007/s11920-024-01490-8
24. Liu X, Ping S, Gao W. Changes in undergraduate students' psychological well-being as they experience University Life. *Int J Environ Res Public Health.* 2019;16(16):1-14. doi:10.3390/ijerph16162864
25. Richmond C. Neutropenia and leukopenia after cross taper from quetiapine to divalproex for the treatment of borderline personality disorder. *Fed Pract.* 2022;(39(4)):182-185. doi:10.12788/fp.0247
26. Isnarni E, Sulistyani E. Perubahan jumlah leukosit darah tepi pada kondisi stress penelitian eksperimental laboratories pada tikus wistar jantan. *J Kedokt Gigi Unej.* 2015;7(3):45-48.
27. Kadarwati A, Sukeksi A, Putri GSA. Hubungan jumlah monosit dan nilai laju endap darah (led) terhadap lama pengobatan pasien tuberculosis. *Borneo J Med Lab Technol.* 2023;6(1):394-399. doi:10.33084/bjmlt.v6i1.6077
28. Wahab I, Shara Syafana I, Jumadewi A, Rahmayanti. Gambaran hasil nilai laju endap darah (led) yang segera diperiksa dan ditunda 4 jam dengan metode westergren. *J Med Lab Technol.* 2024;1(2):148-154.
29. Tan M, Luo Y, Hu J, et al. Elevated c-reactive protein and erythrocyte sedimentation rate correlates with depression in psoriasis: a chinese cross-sectional study. *Clin Cosmet Investig Dermatol.* 2023;16(February):397-405. doi:10.2147/CCID.S401934
30. Prasertsri P, Roengrit T, Kanpetta Y, et al. Cashew apple juice supplementation enhances leukocyte count by reducing oxidative stress after high-intensity exercise in trained and untrained men. *J Int Soc Sports Nutr.* 2019;16(1):1-11. doi:10.1186/s12970-019-0299-2

Conflict of Interest Statement

The author(s) declare no commercial, financial, or personal conflicts of interest related to this research. All authors approved the final manuscript and consented to its publication in *Healthy Tadulako Journal*.

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