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### Viral Load, CD4 Count, NLR, SGPT, and eGFR Levels as Factors Associated with Quality of Life in HIV Patients

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Human Immunodeficiency Virus (HIV) infection remains a major global health problem and may affect the quality of life of people living with HIV. Quality of life can be assessed using the World Health Organization Quality of Life-Human Immunodeficiency Virus BREF (WHOQOL-HIV BREF) questionnaire. This study aimed to analyze the association of viral load, CD4 count, neutrophil-to-lymphocyte ratio (NLR), serum glutamic pyruvic transaminase (SGPT), and estimated glomerular filtration rate (eGFR) with quality of life among HIV patients. This observational analytic study used a cross-sectional design and was conducted at the Voluntary Counseling and Testing Clinic of Dr. Moewardi Hospital, Surakarta, Central Java, Indonesia. A total of 100 HIV patients undergoing antiretroviral therapy were included based on predefined inclusion and exclusion criteria. The independent variables were viral load, CD4 count, NLR, SGPT, and eGFR, while the dependent variable was quality of life assessed using the WHOQOL-HIV BREF questionnaire. Clinical and laboratory data were obtained from medical records. Data were analyzed using univariate analysis, Spearman correlation test, and ordinal logistic regression with SPSS version 29.0. Higher viral load, lower CD4 count, and elevated NLR were significantly associated with poorer quality of life. In contrast, SGPT and eGFR were not significantly associated with quality of life. In the multivariate analysis, CD4 count showed the strongest association with quality-of-life category. These findings suggest that viral load, CD4 count, and NLR are associated with quality of life among HIV patients. The integration of virological, immunological, and inflammatory markers may complement clinical assessment of quality of life in people living with HIV, particularly in the Indonesian clinical setting. Further longitudinal studies are needed to clarify their predictive value.

**Keywords:** HIV, CD4, eGFR, NLR, SGPT, Quality of life, Viral load

#### INTRODUCTION

Human Immunodeficiency Virus (HIV) infection remains a major global public health problem. In 2024, approximately 40.8 million people were living with HIV worldwide, with 1.3 million new HIV infections and 630,000 deaths from AIDS-related illnesses (UNAIDS, 2025). Despite substantial improvements in antiretroviral therapy (ART), HIV infection continues to impose long-term clinical, psychological, social, and functional burdens on people living with HIV. In Indonesia, HIV remains an important public health concern. As of March 2025, the estimated number of people living with HIV in Indonesia was approximately 564,000, of whom 356,638 had been identified, 239,819 were receiving treatment, and only

around 132,575 had achieved viral suppression (Ministry of Health of the Republic of Indonesia, 2025). These data indicate that achieving treatment coverage and viral suppression remains a major challenge in Indonesia.

Quality of life is an important outcome in the management of people living with HIV because it reflects not only disease control, but also physical health, psychological well-being, level of independence, social relationships, environmental conditions, and spirituality. Quality of life among people living with HIV can be assessed using the World Health Organization Quality of Life-Human Immunodeficiency Virus BREF (WHOQOL-HIV BREF), a specific instrument developed to evaluate quality of life in HIV populations. This instrument measures six

domains, including physical health, psychological well-being, level of independence, social relationships, environmental conditions, and spirituality/religion/personal beliefs (WHO, 2002). The Indonesian version of the WHOQOL-HIV BREF has been tested and reported to be valid and reliable for measuring quality of life among Indonesian patients with HIV/AIDS (Muhammad et al., 2017).

Several clinical markers are routinely used to monitor HIV disease progression and treatment response. Viral load reflects the level of HIV replication and is an important indicator of treatment effectiveness, while CD4 count represents immune status and the risk of opportunistic infections. Previous studies have shown that lower or undetectable viral load and higher CD4 count are associated with better health-related quality of life among people living with HIV (Mwesigire et al., 2015; Katende-Kyenda, 2023; Nurwijayanti et al., 2023). However, quality of life in HIV patients may not be explained only by virological suppression and immune recovery. Chronic systemic inflammation, treatment-related toxicity, liver dysfunction, renal impairment, comorbidities, and psychosocial conditions may also contribute to reduced quality of life.

The neutrophil-to-lymphocyte ratio (NLR) has recently gained attention as a simple inflammatory biomarker derived from routine complete blood count examination. In people living with HIV, elevated NLR may reflect systemic inflammation, immune activation, and disease severity. Previous studies have suggested that NLR is associated with clinical outcomes and mortality risk in HIV-infected patients (Silva et al., 2014; Hasna et al., 2024; Guo et al., 2025). In addition to inflammatory status, organ function markers are also clinically important in HIV care. Serum glutamic pyruvic transaminase (SGPT) reflects liver function and may increase due to hepatitis coinfection, drug-induced liver injury, metabolic disorders, or ART-related hepatotoxicity. Estimated glomerular filtration rate (eGFR) is used to assess renal function, which is relevant because HIV infection and long-term ART exposure may contribute to kidney impairment, including HIV-associated nephropathy and chronic kidney disease (Wawan et al., 2021; Rossing et al., 2022).

Previous studies in Indonesia have evaluated quality of life among people living with HIV in several settings. However, most of these studies have focused mainly on sociodemographic, psychosocial, stigma-related, depression-related, social support, and ART adherence factors. For example, Sitorus et al. (2023) evaluated health-related quality of life among people living with HIV based on sexual orientation in Indonesia, while Buntoro et al. (2024) reported that social support, ART adherence, depression symptoms, education level, income, and duration of diagnosis were associated with quality of life among people living with HIV in Kupang. These studies provide important evidence, but the combined association of virological, immunological, inflammatory, hepatic, and renal markers with quality of life among Indonesian HIV patients remains underexplored.

This gap is clinically important because HIV management in Indonesia requires accessible and practical markers that can support comprehensive patient assessment beyond conventional viral load and CD4 monitoring. Although the association between viral load, CD4 count, and quality of life among people living with HIV has been widely documented, most previous studies have focused mainly on virological and immunological parameters, while evidence regarding the combined use of inflammatory biomarkers and organ function markers remains limited, particularly in the Indonesian clinical setting. The neutrophil-to-lymphocyte ratio (NLR) is relevant in resource-limited settings because it can be calculated from routine hematological examinations and may reflect systemic inflammation and immune dysregulation, whereas SGPT and eGFR represent hepatic and renal function, which are clinically important in patients receiving long-term antiretroviral therapy. Therefore, integrating viral load, CD4 count, NLR, SGPT, and eGFR in a single predictive model may provide a broader understanding of biological factors associated with quality of life among Indonesian people living with HIV. Based on this background, this study aimed to analyze the effect of viral load, CD4 count, NLR, SGPT, and eGFR levels on quality-of-life scores among HIV patients receiving antiretroviral therapy at the VCT Clinic of Dr. Moewardi Hospital, Surakarta, Indonesia.

## METHODS

This study employed an analytical observational design with a cross-sectional approach, aiming to evaluate the influence of viral load, CD4 count, neutrophil-to-lymphocyte ratio (NLR), serum glutamic pyruvate transaminase (SGPT), and estimated glomerular filtration rate (eGFR) on the quality of life of HIV patients. The study was conducted at the Voluntary Counseling and Testing (VCT) Clinic of Dr. Moewardi Hospital, Central Java, using patient data collected from January to December 2024.

The target population consisted of all individuals living with HIV in Indonesia, while the accessible population included HIV patients receiving treatment at the VCT Clinic of Dr. Moewardi Hospital. Subjects were selected using purposive sampling based on predefined inclusion and exclusion criteria. This sampling approach was chosen to ensure that all participants had complete clinical, laboratory, and quality-of-life data and were clinically stable during the study period. However, because purposive sampling is a non-probability sampling technique, it may introduce selection bias. Therefore, the selected participants may not fully represent the broader population of people living with HIV in Indonesia.

1. Inclusion criteria: HIV patients aged 18–65 years, physically stable, communicative, and undergoing regular antiretroviral (ARV) therapy for at least 6 months.
2. Exclusion criteria: Patients with interrupted ARV therapy for  $\geq 3$  consecutive months or those with comorbid chronic diseases such as cancer, hypertension, kidney failure, or diabetes mellitus.

Patients with chronic comorbid diseases, including cancer, hypertension, kidney failure, and diabetes mellitus, were excluded to reduce heterogeneity and minimize the influence of severe non-HIV-related conditions on quality-of-life assessment. However, this exclusion criterion may have restricted the variability of organ function parameters, particularly eGFR and SGPT, and may limit the interpretation of their association with quality of life.

The minimum sample size was calculated using the formula for testing a correlation coefficient with Fisher's z transformation, because this study aimed to examine the association between laboratory parameters and quality-of-life score. The formula used was as follows:

$$n = \left[ \frac{Z_{\alpha} + Z_{\beta}}{0.5 \times \ln \left( \frac{1+r}{1-r} \right)} \right]^2 + 3$$

where  $Z_{\alpha}$  is the standard normal value for a two-sided significance level of 5% ( $Z_{\alpha} = 1.96$ ),  $Z_{\beta}$  is the standard normal value for 80% statistical power ( $Z_{\beta} = 0.84$ ), and  $r$  is the expected correlation coefficient. An expected moderate correlation coefficient of 0.41 was used based on previous studies reporting associations between clinical or laboratory parameters and quality of life among people living with HIV.

Using these assumptions, the minimum sample size was calculated as follows:

$$n = \left[ \frac{1.96 + 0.84}{0.5 \times \ln \left( \frac{1 + 0.41}{1 - 0.41} \right)} \right]^2 + 3$$

$$n = \left[ \frac{2.80}{0.5 \times \ln \left( \frac{1.41}{0.59} \right)} \right]^2 + 3$$

$$n = \left[ \frac{2.80}{0.435} \right]^2 + 3$$

$$n = 44.4 \approx 45$$

Therefore, the minimum required sample size was 45 subjects. However, the final sample size was increased to 100 subjects to improve the precision of estimates, reduce the risk of unstable regression coefficients, and meet the practical requirements for multivariable ordinal logistic regression. Since five laboratory variables were evaluated in this study, a larger sample was considered necessary to provide a more reliable multivariable analysis and to reduce the possibility of model overfitting.

### Operational Definition of Variables

1. **Viral Load:** The number of HIV RNA copies per mL of plasma, measured using PCR-based techniques. Viral load reflects viral replication and treatment response. In this study, viral load was categorized as undetected and detected, based on the laboratory reporting threshold.
2. **CD4 Count:** The number of CD4+ T lymphocytes per mm<sup>3</sup> of blood, analyzed using flow cytometry. CD4

count was categorized into three clinical groups: <200 cells/mm<sup>3</sup>, 200–499 cells/mm<sup>3</sup>, and ≥500 cells/mm<sup>3</sup>. A CD4 count below 200 cells/mm<sup>3</sup> indicates advanced immunosuppression and increased risk of opportunistic infections, while a CD4 count of ≥500 cells/mm<sup>3</sup> indicates relatively preserved immune status (WHO, 2025; Garcia et al., 2025).

3. **NLR:** Neutrophil-to-lymphocyte ratio, calculated by dividing the absolute neutrophil count by the absolute lymphocyte count from routine complete blood count results. NLR reflects systemic inflammation and immune status. In this study, NLR was categorized as normal <3.53 and increased ≥3.53.
4. **SGPT:** Serum glutamic pyruvic transaminase, also known as ALT, is a liver enzyme measured in IU/L using a photometric method. SGPT reflects liver cell injury and is useful for monitoring hepatic safety during ART. In this study, SGPT was categorized as normal <45 IU/L and increased ≥45 IU/L.
5. **eGFR:** Estimated glomerular filtration rate, calculated from serum creatinine using standard eGFR equations. eGFR reflects renal function and is important for monitoring kidney safety in HIV patients. In this study, eGFR was categorized as Stage 1 ≥90, Stage 2 60–89, Stage 3 30–59, Stage 4 15–29, and Stage 5 <15 mL/min/1.73 m<sup>2</sup>.
6. **Quality of Life:** Measured using the Indonesian version of the WHOQOL-HIV BREF, consisting of 31 items across six domains: physical, psychological, independence, social relationships, environment, and spirituality. QoL scores were categorized as poor: 1–39.9, moderate: 40–69.9, and good: 70–100.

### Study Instruments

Quality of life was assessed using the Indonesian version of the World Health Organization Quality of Life-Human Immunodeficiency Virus BREF (WHOQOL-HIV BREF) questionnaire. This instrument consists of 31 items covering six domains: physical health, psychological well-being, level of independence, social relationships, environmental conditions, and spirituality/religion/personal beliefs. The Indonesian version of the WHOQOL-HIV BREF has previously been validated in Indonesian HIV/AIDS patients and demonstrated acceptable validity and reliability, with Cronbach's alpha values ranging from 0.513 to 0.798 (Muhammad et al., 2017). Therefore, this instrument was considered appropriate for assessing quality of life in the present study.

### Laboratory Tests:

1. Viral load: PCR-based assay
  2. CD4 count: Flow cytometry
  3. NLR: Derived from neutrophil and lymphocyte counts
  4. SGPT: Photometric testing
  5. eGFR: Calculated from routine blood chemistry
- Clinical data: Extracted from medical records and patient interviews

## Data Analysis

All statistical analyses were performed using SPSS version 29.0. Descriptive statistics were used to summarize baseline characteristics. Continuous variables were presented as mean  $\pm$  standard deviation or median with interquartile range, depending on data distribution. Categorical variables were presented as frequency and percentage. The normality of numerical variables was assessed using the Kolmogorov–Smirnov test.

Bivariate analysis was conducted using the Spearman rank correlation test because most numerical variables were not normally distributed and the quality-of-life variable was analyzed as an ordinal outcome. Variables with p-values  $<0.05$  in bivariate analysis were included in the multivariable ordinal logistic regression model.

Ordinal logistic regression was used to evaluate independent associations between laboratory variables and quality-of-life category. The quality-of-life outcome was ordered as poor, moderate, and good. The proportional odds assumption was assessed using the Test of Parallel Lines. The assumption was considered fulfilled when the p-value was  $>0.05$ , indicating that the relationship between each independent variable and the cumulative logits of the outcome was consistent across QoL thresholds. Model fit was evaluated using goodness-of-fit statistics, and model explanatory ability was assessed using the Nagelkerke pseudo  $R^2$  value. Odds ratios (ORs) were calculated by exponentiating the regression coefficients. In this model, ORs were interpreted as the odds of being in a higher quality-of-life category. Therefore, OR  $<1.00$  indicates lower odds of better quality of life compared with the reference category.

## Research Ethics

This study was conducted following ethical clearance issued by the Ethics Committee of Dr. Moewardi Hospital / Faculty of Medicine, Sebelas Maret University, Surakarta, Indonesia, with approval number 2.572/X/HREC/2024. Before data collection, all eligible participants were informed about the study objectives, procedures, potential risks and benefits, voluntary

participation, and confidentiality of their data. Written informed consent was obtained from all participants. Participants were also informed that they had the right to withdraw from the study at any time without affecting their medical care. All collected data were anonymized and handled confidentially.

## RESULT AND DISCUSSION

### Sample Characteristics

This study involved 100 HIV patients undergoing antiretroviral therapy at the VCT Clinic of Dr. Moewardi Hospital. The mean age of the subjects was  $40.63 \pm 13.18$  years, with the highest proportion in the 31–40 years age group (29%), followed by 21–30 years (25%), and 41–50 years (22%). A total of 74 subjects (74%) were male, and 26 (26%) were female.

In terms of nutritional status, the majority of patients were normoweight (53%), followed by obese (23%), overweight (16%), and underweight (8%). The most commonly used antiretroviral regimens were Tenofovir + Lamivudine + Dolutegravir (45%) and Tenofovir + Lamivudine + Efavirenz (36%).

Based on CD4 count classification, 22 patients had CD4 count  $<200$  cells/mm<sup>3</sup>, 32 patients had CD4 count 200–499 cells/mm<sup>3</sup>, and 46 patients had CD4 count  $\geq 500$  cells/mm<sup>3</sup>. These categories indicate low CD4 count/advanced immunosuppression, moderate immune status, and preserved immune status, respectively.

Regarding opportunistic infections, 54% of patients had one opportunistic infection, 23% had none, and the remainder had two or more. Laboratory parameters showed the following mean values:

1. Viral load:  $2,517.07 \pm 15,232.24$  IU/mL
2. CD4:  $467.62 \pm 327.59$  cells/mm<sup>3</sup>
3. NLR:  $2.93 \pm 1.77$
4. SGPT:  $32.54 \pm 31.45$   $\mu$ /L
5. eGFR:  $99.10 \pm 26.25$  mL/min/1.73 m<sup>2</sup>

The mean quality of life (QoL) score was  $73.12 \pm 9.19$ . Based on WHOQOL-HIV BREF categories, 63% of patients had good QoL, 33% moderate, and 4% poor.

**Table 1**  
Characteristics of Research Subjects (n = 100)

| Variables          | Category    | Frequency | Percentage (%)    |
|--------------------|-------------|-----------|-------------------|
| Age (years)        |             |           | $40.63 \pm 13.18$ |
|                    | <21         | 1         | 1.0               |
|                    | 21–30       | 25        | 25.0              |
|                    | 31–40       | 29        | 29.0              |
|                    | 41–50       | 22        | 22.0              |
|                    | 51–60       | 14        | 14.0              |
|                    | >60         | 9         | 9.0               |
| Gender             | Man         | 74        | 74.0              |
|                    | Woman       | 26        | 26.0              |
| Nutritional status | Underweight | 8         | 8.0               |

| Variables              | Category                              | Frequency | Percentage (%) |
|------------------------|---------------------------------------|-----------|----------------|
| Therapy Regimen        | Normoweight                           | 53        | 53.0           |
|                        | Overweight                            | 16        | 16.0           |
|                        | Obese                                 | 23        | 23.0           |
|                        | Tenofovir + Lamivudine + Dolutegravir | 45        | 45.0           |
|                        | Tenofovir + Lamivudine + Efaviren     | 36        | 36.0           |
|                        | Duviral + Neviral                     | 11        | 11.0           |
|                        | Tenofovir + Lamivudine + Aluvia       | 3         | 3.0            |
|                        | Tenofovir + Emricitabine + Aluvia     | 2         | 2.0            |
|                        | Tenofovir + Aluvia                    | 2         | 2.0            |
|                        | Aluvia + Duviral                      | 1         | 1.0            |
|                        | Number of Opportunistic Infections    | 0         | 23             |
| 1                      |                                       | 54        | 54.0           |
| 2                      |                                       | 13        | 13.0           |
| 3                      |                                       | 6         | 6.0            |
| 4                      |                                       | 4         | 4.0            |
| Laboratory Examination | Viral Load (IU/mL)                    |           |                |
|                        | Undetected                            | 70        | 70             |
|                        | Detected                              | 30        | 30             |
|                        | CD4 (cells/mm <sup>3</sup> )          |           |                |
|                        | < 200                                 | 22        | 22             |
|                        | 201 – 500                             | 32        | 32             |
|                        | > 500                                 | 46        | 46             |
|                        | NLR                                   |           |                |
|                        | < 3.53                                | 70        | 70             |
|                        | ≥ 3.53                                | 30        | 30             |
|                        | SGPT (μ/L)                            |           |                |
|                        | < 45                                  | 81        | 81             |
|                        | ≥ 45                                  | 19        | 19             |
|                        | eGFR (mL/min/1.73m <sup>2</sup> )     |           |                |
|                        | Stage 1 : ≥ 90                        | 65        | 65             |
| Stage 2 : 60-89        | 25                                    | 25        |                |
| Stage 3 : 30-59        | 7                                     | 7         |                |
| Stage 4 : 15-29        | 2                                     | 2         |                |
| Stage 5 : < 15         | 1                                     | 1         |                |
| QoL Score              | Score 1-39.9 : bad                    | 4         | 4              |
|                        | Score 40 – 69.9 : moderate            | 33        | 33             |
|                        | Score 70-100 : good                   | 63        | 63             |

### Bivariate Analysis

Bivariate analysis showed that viral load, CD4 count, and NLR were significantly associated with quality

of life. Viral load was associated with QoL category ( $p = 0.033$ ), with patients with detected viral load showing a higher proportion of poorer QoL categories compared with

those with undetected viral load. CD4 count was significantly associated with QoL ( $p = 0.003$ ), with higher CD4 categories showing a greater proportion of good QoL. NLR was also significantly associated with QoL ( $p = 0.010$ ), with increased NLR associated with poorer QoL

distribution. In contrast, SGPT and eGFR were not significantly associated with QoL, with  $p$ -values of 0.512 and 0.848, respectively.

**Table 2**  
Relationship of Independent Variables to Quality of Life Scores

| Variables  | Category                      | Bad (n/%) | Medium (n/%) | Good (n/%) | Total (n/%) | p-value |
|------------|-------------------------------|-----------|--------------|------------|-------------|---------|
| Viral Load | Undetected                    | 4 (4.0%)  | 22 (22.0%)   | 48 (48.0%) | 70 (70.0%)  | 0.033   |
|            | Detected                      | 4 (4.0%)  | 11 (11.0%)   | 15 (15.0%) | 30 (30.0%)  |         |
| CD4        | <200 cells/mm <sup>3</sup>    | 1 (1.0%)  | 7 (7.0%)     | 14 (14.0%) | 22 (22.0%)  | 0.003   |
|            | 200–499 cells/mm <sup>3</sup> | 2 (2.0%)  | 20 (20.0%)   | 10 (10.0%) | 32 (32.0%)  |         |
|            | ≥500 cells/mm <sup>3</sup>    | 1 (1.0%)  | 6 (6.0%)     | 39 (39.0%) | 46 (46.0%)  |         |
| NLR        | Normal                        | 0 (0.0%)  | 21 (21.0%)   | 49 (49.0%) | 70 (70.0%)  | 0.010   |
|            | Increase                      | 4 (4.0%)  | 12 (12.0%)   | 14 (14.0%) | 30 (30.0%)  |         |
| SGPT       | Normal                        | 4 (4.0%)  | 27 (27.0%)   | 50 (50.0%) | 81 (81.0%)  | 0.512   |
|            | Increase                      | 0 (0.0%)  | 6 (6.0%)     | 13 (13.0%) | 19 (19.0%)  |         |
| eGFR       | Stage 1                       | 4 (4.0%)  | 19 (19.0%)   | 42 (42.0%) | 65 (65.0%)  | 0.848   |

### Multivariate Analysis

Variables that were significantly associated with quality of life in bivariate analysis, namely viral load, CD4 count, and NLR, were included in the ordinal logistic regression model. Before interpreting the final model, the proportional odds assumption was evaluated using the Test of Parallel Lines. The results of this diagnostic test should be reported to confirm whether the ordinal logistic regression model was appropriate.

In the ordinal logistic regression model, only CD4 count remained statistically significant after adjustment. Compared with patients with preserved CD4 count, patients in the moderate CD4 category had significantly lower odds of being in a higher quality-of-life category (OR = 0.08; 95% CI: 0.03–0.25;  $p = 0.001$ ). This indicates that

patients with moderate CD4 count were less likely to report better QoL than those with higher CD4 count. When expressed in the opposite direction, patients with CD4 count of 200–499 cells/mm<sup>3</sup> had approximately 12.5 times higher odds of being in a lower QoL category compared with CD4 count ≥500 cells/mm<sup>3</sup> group.

Detected viral load was not independently associated with QoL after adjustment (OR = 2.97; 95% CI: 0.76–11.60;  $p = 0.117$ ). Increased NLR was also not independently associated with QoL in the adjusted model (OR = 1.30; 95% CI: 0.35–4.89;  $p = 0.698$ ). The Nagelkerke pseudo R<sup>2</sup> value was 0.322, indicating that the variables included in the model explained approximately 32.2% of the variation in quality-of-life category.

**Table 1**  
Results of Multiple Ordinal Logistic Regression Analysis on Quality of Life Scores

| Variable          | Category   | β coefficient | OR   | 95% CI for OR | p-value |
|-------------------|--|---------------|------|---------------|---------|
| <b>Viral load</b> | Detected vs undetected                                   | 1.090         | 2.97 | 0.76–11.60    | 0.117   |
| <b>CD4 count</b>  | <200 cells/mm <sup>3</sup> vs ≥500 cells/mm <sup>3</sup> | -1.107        | 0.33 | 0.10–1.13     | 0.077   |

| Variable             | Category  | $\beta$ coefficient | OR    | 95% CI for OR | p-value |
|----------------------|---|---------------------|-------|---------------|---------|
| <b>CD4 count</b>     | 200–499 cells/mm <sup>3</sup> vs $\geq$ 500 cells/mm <sup>3</sup> | -2.532              | 0.08  | 0.03–0.25     | 0.001   |
| <b>NLR</b>           | Increased vs normal   | 0.262               | 1.30  | 0.35–4.89     | 0.698   |
| <b>Model summary</b> | Nagelkerke pseudo R <sup>2</sup>                                  |                     | 0.322 |               |         |

The results of this study indicate that the average age of the subjects was 40 years and 8 months and the majority were male. Globally, in 2023 there will be 39.9 million people living with HIV, consisting of 38.6 million adults and 1.4 million children. In the United States, the 25–34 age group recorded the most new HIV infections in 2022, while women account for 53% of all PLWHA. 15 Indonesian data shows that the 30–39 age group (47.8%) and 40–49 age groups (29.5%) are most affected, and women are the dominant group, in contrast to this study which was dominated by men. The average viral load was 2,517.07 copies/mL and the average CD4 was 467.62 cells/mm<sup>3</sup>, within the normal range of 410–1,590 cells/mm<sup>3</sup> (Effendy et al., 2019). The average NLR of 2.93 (normal <3.53), SGPT of 32.54  $\mu$ /L (normal 0–34 u/L), and eGFR of 99.10 mL/min/1.73 m<sup>2</sup> (normal >90) indicated a relatively stable physiological status of the subjects. The average quality of life (QoL) score was 73.12, which is in the normal category (Schneider et al., 2010).

This study found that viral load had a negative and significant effect on QoL, in line with the findings of Barger et al. (2016) and Jocelyn (2024), which stated that low or undetectable viral load correlated with improvements in physical, social function, and psychological health. Adherence to ART is key to maintaining low viral load and improving QoL, and in this study, subjects had been on ART for an average of 6 years and 5 months. In addition, CD4 count also showed a significant positive relationship to QoL. High CD4 levels indicate a strong immune system, which improves the health and daily functioning of PLWHA (Garcia et al., 2025; Katende-Kyenda, 2023). A decrease in the number of opportunistic infections was also correlated with improved QoL in this study. Although a meta-analysis by Ghiasvand et al. (2019) found a negative relationship between CD4 and QoL, they also concluded that ART had a positive impact on QoL, and comorbidities decreased QoL (Ghiasvand et al., 2019). A study in Uganda by Mwesigire et al. (2015) stated that QoL is more influenced by economic and psychosocial factors than CD4 (Mwesigire et al., 2015).

In this study, elevated NLR was significantly associated with poorer QoL in bivariate analysis. However, this association was no longer statistically significant after adjustment in the ordinal logistic regression model. Therefore, NLR should be interpreted as a bivariate correlate rather than an independent factor associated with QoL in the present study. Nevertheless, the observed relationship between NLR and QoL remains biologically plausible. NLR reflects the balance between innate inflammatory activity, represented by neutrophils, and

adaptive immune status, represented by lymphocytes. In HIV infection, persistent viral replication, microbial translocation, immune activation, and opportunistic infections may increase systemic inflammation and neutrophil activation, while simultaneously contributing to lymphocyte depletion. This inflammatory imbalance may be reflected by an increased NLR. A recent systematic review and meta-analysis also reported that higher NLR was associated with poorer clinical outcomes among patients with AIDS, suggesting that NLR may reflect disease severity and systemic inflammatory burden (Guo et al., 2025).

The possible link between increased NLR and lower QoL may occur through several pathways. First, chronic inflammation may contribute to fatigue, reduced physical capacity, appetite disturbance, sleep problems, and impaired daily functioning, all of which are important components of QoL. Second, a higher NLR may indicate lower lymphocyte-mediated immune reserve and greater vulnerability to opportunistic infections. In this study, additional analysis showed that a higher number of opportunistic infections was associated with lower QoL, supporting the possibility that inflammatory and infectious burdens may reduce perceived health status. Third, chronic immune activation may also affect psychological well-being through inflammatory pathways related to mood symptoms, stress response, and reduced functional resilience. Thus, although NLR was not independently associated with QoL after adjustment, it may still provide clinically useful information as an accessible inflammatory marker reflecting broader immune and inflammatory conditions in HIV patients.

The non-significant adjusted association between NLR and QoL suggests that the relationship between inflammation and QoL may be mediated or confounded by other clinical factors, particularly CD4 count. Previous local evidence from HIV patients treated at Dr. Moewardi Hospital also reported that NLR was associated with CD4 count, supporting the possibility that NLR partly reflects immune status rather than acting as an independent determinant of QoL (Hasna et al., 2024). Therefore, future studies should evaluate NLR together with CD4 count, opportunistic infection burden, ART adherence, inflammatory cytokines, and psychosocial variables to clarify whether NLR has an independent role in explaining QoL among people living with HIV.

The absence of significant associations between SGPT, eGFR, and QoL should also be interpreted carefully. In this study, patients with chronic diseases such as hypertension, diabetes mellitus, kidney failure, and cancer

were excluded. This criterion may have resulted in a relatively clinically stable sample with limited variation in hepatic and renal function markers. As shown in the descriptive findings, most patients had normal SGPT and preserved eGFR, which may have reduced the statistical ability to detect meaningful associations between organ function markers and QoL. Therefore, the non-significant findings for SGPT and eGFR do not necessarily indicate that hepatic and renal function are unrelated to QoL in people living with HIV. Rather, these results may reflect the restricted clinical variability of the study population.

Although eGFR showed a positive direction of association with QoL, this association was not statistically significant. This may be explained by the fact that the mean eGFR in this study was within the normal category, while the mean QoL score was also in the good category. eGFR is used as a renal filtration parameter to estimate kidney function based on endogenous biomarkers and individual factors, and it remains important in the long-term monitoring of people living with HIV (Rossing et al., 2022). These findings suggest that stable kidney function remains clinically relevant in HIV care, even though significant renal impairment was not observed in most participants in this study.

In the bivariate analysis, viral load, CD4 count, and NLR were significantly associated with QoL. These findings suggest that virological control, immune status, and systemic inflammation may be clinically relevant to QoL among people living with HIV. However, after adjustment in the ordinal logistic regression model, only CD4 count remained statistically significant, while viral load and NLR were no longer independently associated with QoL. This indicates that the bivariate associations of viral load and NLR with QoL may be partly explained by their relationship with immune status or other clinical factors. Therefore, viral load and NLR should be interpreted as bivariate correlates of QoL in this study, whereas CD4 count showed the strongest independent association in the adjusted model.

This distinction is important because bivariate analysis evaluates the relationship between each independent variable and QoL separately, without controlling for other variables. In contrast, ordinal logistic regression assesses whether each variable remains associated with QoL after considering other variables in the model. The multivariable analysis clarified that not all variables significant in bivariate analysis remained significant after adjustment. This suggests that immune status may have the strongest independent association with QoL in this study population. The non-significant adjusted associations for viral load and NLR may indicate that their bivariate relationships with QoL were partly explained by CD4 count or other clinical factors included in the model.

The odds ratio for the moderate CD4 category should be interpreted according to the direction of the ordinal outcome. Because QoL was ordered from poor to moderate to good, the OR of 0.08 indicates that patients with CD4 count of 200–499 cells/mm<sup>3</sup> had lower odds of

being in a higher QoL category compared with patients with CD4 count  $\geq 500$  cells/mm<sup>3</sup>. Thus, this finding does not indicate a protective effect. Rather, it indicates a poorer QoL distribution among patients with lower CD4 count compared with those in the preserved CD4 reference group.

The findings of this study should also be interpreted within the multidimensional nature of QoL. Although laboratory biomarkers are clinically important, QoL among people living with HIV is not determined only by virological, immunological, inflammatory, hepatic, or renal status. Psychological, social, economic, and behavioral factors may have equal or even stronger influences on QoL. Depression, anxiety, perceived stigma, low social support, poor ART adherence, low income, unemployment, low educational level, and limited access to healthcare may reduce QoL through psychological distress, social isolation, financial insecurity, poor treatment engagement, and delayed healthcare utilization. Studies in HIV populations have consistently shown that stigma is associated with poorer mental and physical health, reduced social support, and lower overall QoL.

This limitation is particularly relevant to the present study because the multivariable model included only laboratory variables. The Nagelkerke pseudo R<sup>2</sup> value of 0.322 indicates that the included laboratory markers explained only part of the variation in QoL, while a substantial proportion remained unexplained. This unexplained variation may be related to unmeasured psychosocial, socioeconomic, behavioral, and treatment-related factors. Previous Indonesian studies support this interpretation. A study among people living with HIV in Kupang reported that social support, ART adherence, depression level, education level, income level, and duration of diagnosis were significantly associated with QoL. Another Indonesian study also emphasized the role of resilience and social support in QoL among people living with HIV/AIDS.

Therefore, the present findings should not be interpreted as indicating that laboratory biomarkers alone are sufficient to explain QoL among HIV patients. Rather, viral load, CD4 count, NLR, SGPT, and eGFR should be viewed as biological correlates that may complement, but not replace, psychosocial assessment. A more comprehensive model of QoL in HIV should integrate biological markers with depression screening, stigma assessment, ART adherence evaluation, socioeconomic status, educational background, employment status, and social support. Such an approach would be more consistent with the WHOQOL-HIV BREF framework, which measures QoL across physical, psychological, independence, social, environmental, and spiritual domains.

This study has several limitations. First, the cross-sectional design does not allow causal or predictive conclusions. Second, the use of purposive sampling and the single-center setting may limit generalizability. Third, the exclusion of patients with major chronic comorbidities may have reduced variability in SGPT and eGFR, which

may partly explain the non-significant associations of these organ function markers with QoL. Fourth, although this study evaluated several biological markers, it did not assess psychosocial, socioeconomic, and behavioral determinants of QoL, including depression, anxiety, HIV-related stigma, ART adherence level, income, education, employment status, family support, and social support. Because QoL is multidimensional, the absence of these variables limits the explanatory power of the model. Future studies should use a longitudinal, multicenter design and integrate laboratory biomarkers with psychosocial and socioeconomic variables to develop a more comprehensive biopsychosocial model of QoL among people living with HIV.

Another limitation of this study is that internal consistency testing of the WHOQOL-HIV BREF was not repeated in the current study sample. However, this study used the Indonesian version of the WHOQOL-HIV BREF, which has previously been validated and reported to be reliable among Indonesian HIV/AIDS patients, with Cronbach's alpha values ranging from 0.513 to 0.798 (Muhammad et al., 2017).

## CONCLUSIONS

This study found that viral load, CD4 count, and NLR were significantly associated with quality of life among HIV patients in bivariate analysis. Higher viral load and elevated NLR were associated with lower QoL, while higher CD4 count was associated with better QoL. However, after adjustment using ordinal logistic regression, only CD4 count remained significantly associated with quality-of-life category. Patients with CD4 count of 200–499 cells/mm<sup>3</sup> had lower odds of being in a higher QoL category compared with those with CD4 count  $\geq$ 500 cells/mm<sup>3</sup>. Viral load and NLR were not independently associated with QoL after adjustment, while SGPT and eGFR were not significantly associated with QoL in bivariate analysis.

These findings suggest that CD4 count had the strongest independent association with QoL among the laboratory variables assessed in this study. Given the cross-sectional design, these results should be interpreted as associations rather than causal or predictive relationships. Laboratory biomarkers may complement, but should not replace, a broader quality-of-life assessment that includes psychosocial, socioeconomic, and behavioral factors. Future studies should include variables such as depression, stigma, ART adherence, income, education, and social support to better explain the multidimensional quality of life of people living with HIV.

## SUGGESTION

These findings underscore the importance of monitoring immunologic and inflammatory biomarkers as part of comprehensive management strategies to improve the quality of life among people living with HIV.

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