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Red Cell Distribution Width Predicts 30-Day Disability in Acute Ischemic Stroke

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Abstract

Purpose: We assessed Red Cell Distribution Width (RDW) levels at hospital admission and determined whether RDW could serve as a predictor of disability prognosis in patients with acute ischemic stroke.

Research Methodology: A retrospective cohort study was conducted using data from the stroke registry at Bethesda Hospital, Yogyakarta. RDW levels were measured upon hospital admission. Functional disability at 30 days post-stroke was evaluated using the modified Rankin Scale and analyzed statistically.

Results: Elevated RDW levels were observed in 20.8% of patients. Receiver operating characteristic analysis identified an optimal RDW cutoff value of 14.15%, with an area under the curve of 0.689 (p=0.009). At 30 days after stroke onset, 20% of patients had poor functional outcomes. Bivariate analysis demonstrated a significant association between high RDW levels and poor disability outcomes (p=0.001; OR=14.333). Multivariate logistic regression analysis confirmed that elevated RDW was an independent predictor of 30-day post-stroke disability (OR=4.287; 95% CI: 2.036–9.029; p<0.001).

Conclusions: Elevated RDW at admission is significantly associated with poorer functional outcomes in patients with acute ischemic stroke and may serve as a useful prognostic biomarker.

Limitations: This study relied on secondary data, limiting control over patient conditions and measurement quality. The study population predominantly included mild-to-moderate stroke cases, and potential confounding factors, such as comorbidities, were not evaluated.

Contributions: These findings may enhance prognostic accuracy and support the development of clinical tools for predicting post-stroke disability.

Keywords: *Acute Ischemic Stroke, mRS, Post-Stroke Disability, Red Cell Distribution Width*

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1. Introduction

Stroke is a major cause of death and disability worldwide (Kusuma et al., 2021). The Global Burden of Disease (GBD) estimates that stroke is the third most common cause of mortality and the fourth most common cause of disability worldwide (Feigin et al., 2024). According to data from the Basic Health Research (RISKESDAS), the incidence of stroke in Indonesia increased by 56% to 10.9 per 1,000 people in 2018 (Kesehatan, 2018). Stroke is defined as a neurological deficit that occurs due to vascular disruption, including blockage of blood vessels (ischemic stroke) or rupture of blood vessels (hemorrhagic stroke), which can occur suddenly within seconds or rapidly over hours to years, and is accompanied by symptoms that correspond to the affected area (Widiani & Yasa, 2023). Acute ischemic stroke leads to decreased cerebral perfusion, resulting in neurons lacking sufficient blood and oxygen

supply to maintain proper function (Ilham et al., 2024). Most stroke survivors experience varying degrees of disability and an increase in health, economic, and social burdens due to this condition, which creates a need for early and accurate predictions of the level of disability after a stroke (Putra & Bintoro, 2019).

Among the predictors of post-stroke disability prognosis is Red Cell Distribution Width (RDW) (Mohindra et al., 2019). RDW is a measurement of red blood cell volume variation derived from routine blood tests and provides a more cost-effective predictor for assessing the severity of ischemic stroke (Feng et al., 2017). Changes in RDW are one of the pathological changes in ischemic stroke, which indicates changes in the distribution of red blood cell size (Ilham et al., 2024). High RDW values are associated with poor prognosis in stroke patients within 1–3 months after examination (Feng et al., 2017). However, most existing studies examining the prognostic value of RDW have been conducted in non-Indonesian populations, limiting their generalizability to local clinical settings with different demographic and healthcare characteristics. Furthermore, evidence evaluating RDW measured at hospital admission as an independent predictor of short-term disability using standardized outcomes, such as the modified Rankin Scale, remains scarce in Indonesia.

To date, only a few studies have used Red Cell Distribution Width (RDW) as a predictor of disability prognosis in patients with acute ischemic stroke in Indonesia, particularly at Bethesda Hospital. To the best of our knowledge, no previous study has specifically analyzed the association between admission RDW levels and 30-day post-stroke disability using stroke registry data from Bethesda Hospital, Yogyakarta. Therefore, the objective of this study was to determine whether high RDW can be used as a predictor of disability prognosis in patients with acute ischemic stroke after 30 days at Bethesda Hospital in Yogyakarta. This study is expected to provide novel local evidence on the prognostic utility of RDW, support early risk stratification in acute ischemic stroke, and contribute to the development of accessible and cost-effective prognostic tools for routine clinical practice.

2. Literature Review and Hypothesis Development

Red Cell Distribution Width (RDW) is a hematological parameter that indicates the variation in red blood cell size in the bloodstream. RDW can be obtained from regular blood tests in the form of a percentage. RDW is an indicator of erythrocyte size heterogeneity. An increased RDW value above the normal range (11.5%–14.15%) may indicate certain hematological disorders, including iron deficiency anemia, macrocytic anemia, and various inflammatory conditions (Arkew et al., 2022). In the context of ischemic stroke, patients often exhibit a significant increase in RDW. Oxidative stress and inflammatory reactions occur in response to brain tissue damage. These pathological processes suggest that RDW elevation may reflect systemic responses to cerebral ischemia rather than isolated hematological abnormalities.

An increase in RDW may reflect the body's systemic response to tissue damage and can be used as a prognostic indicator for stroke outcomes, where higher RDW values are often associated with poor clinical outcomes (Stachel et al., 2024). Various studies have shown that stroke patients often exhibit a marked increase in RDW (Dias et al., 2024). One of the contributing factors is oxidative stress caused by brain tissue damage during ischemic events, which induces damage to cell membranes and disrupts red blood cell formation. Additionally, the inflammatory response that occurs after a stroke also contributes to increased RDW (Feng et al., 2017). Systemic inflammation can affect bone marrow function and modulate red blood cell production, leading to greater variation in erythrocyte size (Lubis et al., 2024). Taken together, these mechanisms provide a biological rationale linking elevated RDW to the severity of ischemic injury and subsequent clinical outcomes.

An elevated RDW not only reflects hematological disorders but can also serve as a prognostic indicator for stroke clinical outcomes (Huang et al., 2023). Several studies have found that higher RDW values are often associated with poor clinical outcomes, including higher mortality rates and greater disability levels post-stroke (Dias et al., 2024). This suggests that RDW can serve as a useful biomarker for identifying patients at high risk of post-stroke complications (Toyoda et al., 2022). RDW measurement can provide additional insights into the management of patients with ischemic stroke. By considering

RDW alongside other clinical factors, healthcare professionals can better predict prognosis and formulate more appropriate treatment plans for patients (Stachel et al., 2024). However, despite growing evidence supporting RDW as a prognostic marker, studies specifically examining its role in predicting short-term functional disability using standardized measures remain limited, particularly in local clinical settings. Therefore, this study hypothesizes that high RDW can be used as a predictor of poor disability prognosis in patients with acute ischemic stroke.

The hypotheses developed in this study are as follows.

H_0: High Red Cell Distribution Width (RDW) cannot predict poor disability prognosis in patients with acute ischemic stroke.

H_1: High Red Cell Distribution Width (RDW) can predict poor disability prognosis in patients with acute ischemic stroke.

3. Methodology

This study had a retrospective cohort design. It aimed to determine the Red Cell Distribution Width (RDW) index of patients upon admission to the hospital and assess whether RDW could be used as a predictor of disability prognosis in patients with acute ischemic stroke. The RDW was calculated based on the complete blood count results. The modified Rankin Scale (mRS) was used to evaluate the 30-day clinical outcomes of patients after stroke. Sampling was performed consecutively from the medical records, considering the exclusion and inclusion criteria. The exclusion criteria were acute ischemic stroke with active infection, recurrent stroke, and hematological or immunological disorders.

The inclusion criteria were acute ischemic stroke patients aged >18 years, those with a confirmed diagnosis using head CT, those with complete medical records, particularly Red Cell Distribution Width (RDW) test results, and those with complete follow-up data with a 30-day modified Rankin Scale score. Based on the sample size calculations, a minimum of 120 participants were required. Data analysis included univariate, bivariate, and multivariate analyses. Univariate analysis was performed to describe the demographic and clinical characteristics of the research participants, including RDW values and mRS scores. Bivariate analysis was conducted to examine the association between RDW and mRS using the chi-square test.

Multivariate analysis was performed using binary logistic regression to analyze the association between RDW and 30-day disability outcomes while adjusting for potential confounders. The National Institutes of Health Stroke Scale (NIHSS) was included in the multivariate model to represent baseline stroke severity at hospital admission, which is conceptually distinct from the mRS that reflects functional disability at follow-up. Including the NIHSS in the analytical model allows for control of initial neurological deficits and ensures that the observed association between RDW and disability prognosis is independent of stroke severity. Additional covariates included age, sex, race, cardiovascular disease, diabetes mellitus, hypertension, history of hypertension, and Computed Tomography (CT) findings (number of lesions, presence of atrophy, and lesion location).

4. Results and Discussions

4.1 Results

The data were obtained from the medical records of Bethesda Hospital in Yogyakarta. We included 120 patients with ischemic stroke from 2022 to 2024 who met the inclusion and exclusion criteria in this study.

4.1.1 Univariate Analysis

Table 1. Univariate analysis results

Variables	Frequency	Percentage (%)
Age		
<55 years old	24	20%
≥55 years old	96	80%
Sex		

Female	48	40%
Male	72	60%
Diabetes Mellitus		
Yes	37	30,8%
No	83	69,2%
Hypertension		
Yes	67	55,8%
No	53	44,2%
Cardiovascular disease		
Yes	20	16,7%
No	100	83,3%
Radiology Results		
Cortical Infarction	35	29,2%
Subcortical Infarction	64	53,3%
Infarction	21	17,5%
Atrophy	38	31,7%
No Atrophy	82	68,3%
Single lesion	68	56,7%
Multiple lesions	52	43,3%
Muscle strength		
High (>3)	71	59,2%
Low (≤3)	49	40,8%
NIHSS		
Mild (1-4)	31	25,8%
Moderate (5-15)	89	74,2%
Disability 30 days after stroke (mRS)		
Good (≤2)	96	80%
Poor (>2)	24	20%
RDW		
High (≥ 14.15%)	25	20,8%
Low (< 14.15%)	95	79,2%

The results of the data analysis showed that there were 120 patients with acute ischemic stroke, predominantly aged >55 years. The patients in this study were predominantly men. Modifiable risk factors included a history of hypertension, a history of diabetes mellitus, and a history of cardiovascular disease. Among these risk factors, hypertension was the most common, whereas diabetes mellitus and cardiovascular disease were less common. Neuroimaging support examination was performed using computed tomography. The results found based on the order of the highest number were subcortical infarction, cortical infarction, and mixed infarction.

From the data above, it was found that most patients did not experience atrophy and had a single lesion. In the muscle strength examination, most patients had good muscle strength. The results of stroke severity measured using the NIHSS at the time of admission showed a predominance of moderate stroke (NIHSS 5-15), followed by mild stroke (NIHSS 1-4). The above data did not show any patients with moderate-severe stroke (NIHSS 15-20) or severe stroke (NIHSS 21-42). The dominant mRS result was a good prognosis (mRS ≤2) compared to patients with a poor prognosis (mRS >2). Low RDW values (<14.15%) were more common than high RDW values (≥14.15%).

4.1.2 Receiver Operating Characteristic Analysis

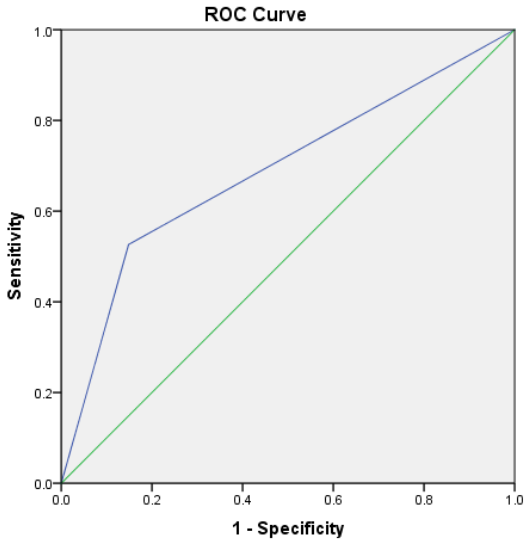

Figure 1. ROC curve result

Table 2. ROC, RDW and mRS 30 days after stroke

Area	Standard error	P value	95% *confidence interval*	
			Lower bound	Upper bound
0,689	0,073	0,009	0,545	0,833

ROC analysis was performed to assess the discriminatory ability of RDW. The results of the ROC analysis showed that the Area Under the Curve (AUC) was 0.689. This result is still considered moderate, indicating that RDW has limited discriminatory ability; however, it is statistically significant and therefore still worthy of consideration in a clinical context. In this study, RDW cutoff analysis was performed using the Youden index method. This analysis was based on the 30-day mRS outcome, with ≤2 indicating good and >2 indicating poor. The results obtained from the analysis showed that the optimal RDW cutoff was 14.15%, with a sensitivity of 52.6% and a specificity of 84.2%.

4.1.3 Bivariate Correlation Analysis

Table 3. Chi square test

Variable	30 days after stroke		OR (95% CI)	P value
	Low (≤2)	High (>2)		
Age				
<55 years old	22 (71,7%)	6 (7,5%)	Reference	
≥55 years old	74 (61,7%)	18 (15%)	0,892 (0,315-2,522)	0,829
Sex				
Female	57 (47,5%)	15 (12,5%)	Reference	
Male	39 (32,5%)	9 (7,5%)	1,140 (0,454-2,942)	0,780
Diabetes Mellitus				
No	66 (55%)	17 (14,2%)	Reference	
Yes	30 (25%)	7 (5,8%)	1,104 (0,414-2,942)	0,843
Hypertension				
No	41 (34,2%)	12 (10%)	Reference	
Yes	55 (45,8%)	12 (10%)	1,341 (0,547-3,288)	0,520
Cardiovascular disease				
No	82 (68,3%)	18 (15%)	Reference	

Yes	14 (11,7%)	6 (5%)	1,952 (0,660-5,772)	0,221
Lession				
Subcortex	69 (57,5%)	16 (13,5%)	Reference	
Cortex	27 (2,5%)	8 (6,7%)	1,278 (0,490-3,331)	0,616
Atrohphy				
No	70 (34,2%)	12 (10%)	Reference	
Yes	26 (21,7%)	12 (10%)	2,692 (1,075-6,743)	0,031*
Lesion				
Single lesion	54 (45%)	14 (11,7%)	Reference	
Multiple lesions	42 (35%)	10 (8,3%)	0,918 (0,371-2,273)	0,854
Muscle strength				
High (>3)	64 (53,3%)	7 (5,8%)	Reference	
Low (≤3)	32 (26,7%)	17 (14,2%)	4,857 (1,828-12,905)	0,001*
NIHSS				
Low (≤4)	29 (24,2%)	2 (1,7%)	Reference	
High (>4)	67 (55,8%)	22 (18,3%)	10,641 (3,867-29,283)	0,001*
RDW				
Low (<14.15%)	86 (71,7%)	9 (7,5%)	Reference	
High (≥14.15%)	10 (8,3%)	15 (12,5%)	14,333 (4,994-41,140)	0,001*

Bivariate correlation analysis was performed to test the relationship between these variables. The chi-square test was used for this analysis. The results of the chi-square test showed that the variables significantly associated with mRS 30 days after stroke were atrophy (p=0.031), muscle strength (p=0.001), NIHSS (p=0.001), and RDW (p=0.001).

4.1.4 Multivariate Analysis

Table 4. Multivariate logistic regression test with mRS disability outcome 30 days after stroke

Variables	Odds ratio	95% CI	P values
Atrofi (Yes)	2,590	0,744 – 9,017	0,135
Muscle strenght (≤3)	0,879	0,399 – 2,196	0,879
NIHSS (high >4)	1,537	1,117 – 2,114	0,008
RDW (high ≥14,15%)	4,287	2,036 – 9,029	<0,001

Multivariate analysis was performed to examine the relationship between confounding variables and dependent variables. The results of the logistic regression test showed that high NIHSS (>4) and high RDW (≥14.15%) had a significant effect on the risk of disability 30 days after stroke, even after adjusting for other variables (p = 0.008 and p = <0.001, respectively). Patients with high RDW had a 4.287 times greater risk of disability than those with low RDW (95% CI = 2.036–9.029). Meanwhile, each 1-point increase in NIHSS increased the risk of disability by 1.537 times (95% CI = 1.117–2.114). NIHSS was used as a confounding variable in this study. Using NIHSS as an independent variable risks circular reasoning because NIHSS itself is an indicator of stroke severity that already encompasses aspects of patient disability measured by the independent variable RDW.

4.2 Discussions

In this study, most patients had low Red Cell Distribution Width (RDW; < 14.15%), with 95 patients (79.2%), followed by patients with high RDW (≥ 14.15%), with 25 patients (20.8%). RDW was significantly associated with post-stroke disability, indicated by an mRS score >2 in bivariate analysis, with an OR of 14.333 (95% CI 4.994–41.140; p=<0.001) and when adjustments were made for other variables in the multivariate analysis, the result was an OR of 4.287 (95% CI=2.036–9.029 and p=<0.001). These results support previous studies, which have shown that increased RDW is associated

with poor clinical outcomes in ischemic stroke through mRS scores >2 (OR=4.703; p=0.049) (Dias et al., 2024).

Other studies have reported a positive correlation between RDW and poor clinical outcomes as assessed by the modified Rankin Scale (mRS) 30 days after stroke (Xue et al., 2022). Elevated RDW reflects erythrocyte heterogeneity, which may indicate inflammation or oxidative stress in the body (Shen & Shen, 2024). This is relevant because inflammatory and neuroinflammatory processes play a central role in the pathogenesis of nervous system disorders, in which microglial activity can trigger more widespread neuronal damage (Berawi & Nugroho, 2021). In the inflammatory process, proinflammatory cytokines (IL-6 and TNF-α) can disrupt erythropoiesis, inhibit erythrocyte maturation, and enhance the release of reticulocytes into the circulation (Wang et al., 2019). This leads to an increase in erythrocyte heterogeneity, as reflected by an increase in RDW. This worsening condition ultimately exacerbates brain tissue damage and slows down the neurological recovery process, contributing to more severe disability (Shen & Shen, 2024). RDW in this study was associated with and predictive of clinical outcomes of post-stroke disability (mRS 30 days post-stroke).

The level of ischemic stroke disability was measured using the modified Rankin Scale (mRS). This study found that most of the study population fell into the good prognosis group (≤2), comprising 96 patients (80%), and no deaths were found in this study population. The mRS assessment was conducted 30 days after ischemic stroke, making it a useful predictor of disability and symptoms at 90 days after stroke (Gardener et al., 2022). The dominant distribution of mRS at 30 days in the good category is likely related to the population distribution, which included patients with mild-to-moderate stroke when measured with the NIHSS admission. Previous studies have also linked NIHSS scores to significant associations with functional outcomes on the 30-day mRS after acute ischemic stroke (Mistry et al., 2021).

In this study, the participants were predominantly aged ≥55 years, totaling 96 patients. After bivariate analysis, age was not significantly associated with the 30-day modified Rankin Scale (mRS) score after stroke (p=0.829). The results of the age variable characteristics are also in line with previous studies, reporting that the highest incidence of stroke occurs in patients aged ≥ 55 years (Widiani & Yasa, 2023). Bivariate analysis showed that age does not directly affect functional outcomes but indirectly affects them through increased frailty (a condition of decreased physiological reserves and resistance to stressors). This is consistent with previous studies, reporting that the effect of age on the 30-day mRS score is largely mediated by frailty markers that can be identified through neuroimaging (Benali et al., 2024).

This study was dominated by male patients, numbering 72. In bivariate analysis, sex was not significantly associated with the 30-day modified Rankin Scale (mRS) (p=0.780). Male sex was dominant because of a tendency toward risky lifestyle patterns and habits, such as smoking and excessive alcohol consumption, which can cause atherosclerosis and lead to ischemic stroke. Excess testosterone can also increase Low-Density Lipoprotein (LDL) levels, which can lead to atherosclerosis in the vascular system (Liu et al., 2022). The bivariate analysis in this study is in line with previous studies, which have shown that sex does not significantly affect the 30-day mRS (Yang et al., 2021). Previous studies have also shown that older women may have worse prognoses because of decreased estrogen levels, which previously played a role in protecting the vasculature. Estrogen has anti-inflammatory and antioxidant effects that are important in maintaining vascular endothelial integrity (Girijala et al., 2016).

The modifiable risk factors for ischemic stroke are hypertension, diabetes, and cardiovascular disease. In this study, the most common modifiable risk factor was hypertension, which was found in 67 patients (55.8%), followed by diabetes in 37 patients (30.8%) and cardiovascular disease in 20 patients (16.7%). The importance of risk factor management is supported by research showing that early identification and holistic management of hypertension are crucial for preventing fatal vascular complications (Perdani & Berawi, 2021). In addition to pharmacological intervention, patients' level of knowledge

regarding adherence to a hypertensive diet also contributes significantly to maintaining blood pressure stability and preventing worsening health conditions (Oktaria et al., 2023).

After bivariate analysis, a history of Diabetes Mellitus (DM), hypertension, and cardiovascular disease showed no significant correlation with modified Rankin Scale (mRS) score 30 days after stroke (p=0.843), (p=0.520), and (p=0.221), respectively. These results are in line with previous studies, which state that hypertension is one of the main risk factors for ischemic stroke, with a 5.97 times greater risk than other modifiable risk factors (Saifullah et al., 2024). Uncontrolled and chronic hypertension can damage the vascular endothelial layer, which can trigger atherosclerosis and cause hemodynamic changes, leading to microangiopathy and disruption of blood supply to the brain (Puspitasari, 2020). The bivariate analysis in this study is not in line with previous studies, which state that a history of diabetes, hypertension, and cardiovascular disease is associated with poor functional outcomes in patients with ischemic stroke (Tanlaka et al., 2022).

Another study also stated that a history of diabetes has a higher risk of poor functional outcomes as measured by the mRS (Kyaw et al., 2024). Previous studies have also stated that hypertension is significantly associated with functional outcomes after ischemic stroke (Liu et al., 2023). These results are inconsistent with previous studies, may be because previous studies considered other factors, such as the management of comorbidities before, during, and after ischemic stroke. Previous studies have found that intensive blood pressure management is significantly associated with good functional outcomes as measured by the mRS 30 days after stroke (Sacco et al., 2024). Another study found that metformin use before stroke was associated with lower mRS scores (0-2) and lower mortality in ischemic stroke patients with a history of diabetes (Elgenidy et al., 2025). The patient's history of comorbid disease treatment was not considered, which may have contributed to the lack of significance in relation to the 30-day mRS.

The location of the lesion in this study was subcortical, affecting 64 patients (53.3%). In the bivariate analysis, the location of the infarction was not significantly associated with the 30-day modified Rankin Scale (mRS) after ischemic stroke (p=0.616). These results are in line with previous studies, reporting that subcortical infarction is the most common type in patients with ischemic stroke (Aldriweesh et al., 2021). Subcortical infarction is also the most common type of infarction in patients with ischemic stroke, especially those with small vessel disease. The bivariate analysis in this study is not in line with previous studies, reporting that patients with subcortical infarction have wide variability in functional outcomes depending on the size and specific location of the lesion (Navalkele et al., 2022). Another study reported that lesions were more likely to occur in the left hemisphere, accounting for 55.6% of the patients (Wang et al., 2022). This indicates that the prognosis of acute ischemic stroke disability may change after considering the location of the lesion in the cerebral hemisphere. The specific location of the lesion was not considered in this study, which resulted in its insignificance to the mRS 30 days after stroke.

Muscle strength in patients with ischemic stroke in this study was predominantly good (>3) in 71 patients (59.2%). Bivariate analysis found a significant association between patient muscle strength and clinical outcomes measured by the modified Rankin Scale (mRS) 30 days post-stroke (p=0.001; OR=4.857; 95%CI=1.828-12.905), but after adjusting for several variables in the multivariate analysis, the muscle strength variable became insignificant (p=0.208). Previous studies have reported that reduced muscle strength at the onset of acute ischemic stroke is associated with poor prognosis of disability (mRS 2-5) (Kim et al., 2025). Another study also reported that muscle strength is associated with poor functional outcomes. However, after including the National Institutes of Health Stroke Scale (NIHSS) admission score in the multivariate analysis, the association between muscle strength and functional outcomes measured by the mRS at 30 days was no longer significant (Han et al., 2024). This suggests that the effect of muscle strength on functional outcomes (30-day mRS) may be mediated by stroke severity as measured by the NIHSS at admission.

The study found that the severity of stroke, as measured using the NIHSS variable at hospital admission, showed that most patients had moderate stroke severity (5–15), totaling 89 patients (74.2%). This was followed by the mild stroke group (1–4) with 31 patients (25.8%). The study also found no moderate-severe (15–20) or severe (21–42) strokes. In bivariate and multivariate analyses, the admission NIHSS score showed a significant association (p=0.029; OR=10.641; 95%CI=3.867-29.283) and (p=0.008; OR=1.537; 95%CI=1.117 – 2.114) with functional outcomes measured by mRS 30 days after stroke. This is consistent with previous studies, which have shown that admission NIHSS scores have a significant association with mortality and functional outcomes measured by mRS 30 days (Ramachandran et al., 2022). The NIHSS score can indicate the severity of neurological deficits through ischemic mechanisms and brain tissue hypoxia that trigger an ischemic cascade involving ATP depletion, excessive glutamate release, and the formation of Reactive Oxygen Species (ROS), leading to neuronal apoptosis or necrosis, which is associated with the level of functional disability in ischemic stroke (You et al., 2024). In this study, the admission NIHSS score was included as a confounding variable because it reflects the initial severity of ischemic stroke. The NIHSS score is the result of the clinical condition at admission and is considered to influence the relationship between RDW levels and disability levels on day 30 (30-day mRS).

The findings of this study indicate that simple laboratory parameters, such as RDW, which are available in routine blood tests, have the potential to be used as early indicators of poor disability risk in patients with acute ischemic stroke. The use of blood biomarkers as determinants of clinical severity has been proven beneficial in various neurological studies to strengthen the accuracy of diagnosis and prognosis (Sinta et al., 2023). Furthermore, the development of predictive models based on biological parameters is in line with advances in modern medical therapy design, which prioritize a rational approach to optimize patient clinical outcomes (Amin et al., 2025). Knowing that high RDW correlates with an increase in 30-day mRS after stroke, doctors can be more vigilant in monitoring patients with high RDW from the time of hospital admission and prepare for earlier rehabilitation interventions.

Early therapies that can be performed include IV thrombolysis (r-tPA) within the first 4.5 hours, vitamins C and E as antioxidants, and MLC901 neuroprotective therapy (Ilham et al., 2024; Morris-Blanco et al., 2022). Previous studies have also stated that administering r-tPA within less than 6 hours can improve neurological recovery in patients with acute ischemic stroke (Maskuri et al., 2024). In addition, the combination of vitamin C and tPA can reduce blood-brain barrier damage, which contributes to neuroprotective effects (Knecht et al., 2018). MLC901 herbal formulation therapy can also enhance the neurovascular repair process, showing potential in accelerating neurological function recovery after stroke (Venketasubramanian et al., 2024). This study adds to the scientific evidence that hematological biomarkers, such as RDW, play a role as predictors of post-stroke disability prognosis and can be included in clinical algorithms for disability prediction.

5. Conclusions

5.1 Conclusion

These findings suggest that elevated Red Cell Distribution Width (RDW) may be used as a predictor of poor disability prognosis in patients with acute ischemic stroke. As a readily available and cost-effective parameter obtained from routine blood examinations, RDW has the potential to support early risk stratification at hospital admission. Incorporating RDW into initial clinical assessments may help clinicians identify patients at a higher risk of unfavorable functional outcomes, enabling closer monitoring, timely interventions, and more individualized rehabilitation planning. Consequently, RDW may serve as a valuable adjunct to established clinical and radiological assessments in early stroke management.

5.2 Research Limitations

This study was limited by the use of secondary data, which restricted control over measurement quality and patient conditions. In addition, the sample lacked diversity, with National Institutes of Health Stroke Scale scores confined to mild-to-moderate stroke severity. Important clinical factors, including comorbidities and lesion hemisphere location, were not evaluated. Furthermore, disability outcomes

were assessed only at 30 days using the modified Rankin Scale, which may not adequately reflect long-term functional changes after stroke.

5.3 Suggestions and Directions for Future Research

Future studies should employ primary data collection to allow greater control over data quality and patient assessment. Research should include patients with a broader range of stroke severity and adjustment for potential confounding factors, such as comorbidities and lesion hemisphere location. Additionally, longer follow-up periods, including 90-day modified Rankin Scale (mRS) assessments, are recommended to better capture long-term functional outcomes and to more accurately evaluate the prognostic value of Red Cell Distribution Width (RDW).

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Author Contributions

KAHK contributed to the conceptualization, study design, data collection, data analysis, and manuscript drafting. RTP contributed to the supervision, methodology refinement, critical revision of the manuscript, and final approval of the version to be published. SNDH contributed to the study design consultation, data interpretation, manuscript review, and final approval of the manuscript.

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