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Validity and Reliability Testing of the Romberg Test Using a Methodological Approach in Stroke Patients

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Abstract

Introduction: One of the challenges post-stroke patients face is a decrease in balance, both static and dynamic. Evaluating static balance is crucial to preventing falls in stroke patients. One tool used to assess static balance is the Romberg test. A good measurement tool requires high validity and reliability. This study aims to evaluate the reliability and validity of the Romberg test to measure static balance in stroke patients.
Methods: This study employed an observational research design with a methodological approach, conducted at Pandan Arang Hospital in Boyolali from September to October 2024. The study population included stroke patients aged over 46 years. A total of 33 subjects were selected using purposive sampling, adhering to inclusion and exclusion criteria. Data were analyzed using descriptive-analytic methods. The validity of the Romberg test was assessed using the Pearson Product Moment, while reliability was measured using Cronbach's Alpha and Intraclass Correlation Coefficients (ICC) to determine internal consistency.
Results: The intra-rater reliability of Cronbach's Alpha for open and closed eyes tests was α=0.947 and α=0.994, respectively, indicating high consistency (ICC=0.973 and ICC=0.997). Similarly, the inter-rater reliability for both open and closed eyes tests showed excellent Cronbach's Alpha values (α=1.000) and high consistency (ICC=1.000). Validity analysis using the Pearson Product Moment for open and closed eyes tests demonstrated high validity ($p<0.001$, $r=0.947$ and $r=0.994$, respectively).
Conclusion: The Romberg test is proven valid and reliable for measuring static balance in stroke patients.

Keywords: validity, reliability, Romberg test, balance, stroke

Introduction

Stroke is a clinical condition characterized by the sudden onset of focal neurological signs that persist for more than 24 hours or result in death, with a suspected cause related to vascular issues (such as infarction or hemorrhage). Stroke can be caused by various diseases and conditions that disrupt blood flow to specific parts of the brain.[1] The location of the lesion in the brain significantly affects the decline in neurological function. Stroke is characterized by four main features: sudden onset, focal involvement of the central nervous system, a lack of rapid recovery, and a vascular cause.[2] Stroke is the third leading cause of mortality and morbidity in several developed countries.[3] According to the 2018 Basic Health Research (RISKESDAS) report, the incidence of stroke in Indonesia has increased. In 2013, the prevalence of stroke patients was 7% per million, rising to 10.9% per thousand in 2018.[4]

Based on its condition, stroke is classified into two types: ischemic stroke and hemorrhagic stroke. Ischemic stroke, or non-hemorrhagic stroke, occurs due to a blockage in blood vessels, leading to partial or complete cessation of blood flow to the brain. In contrast, hemorrhagic stroke occurs as a result of bleeding in brain tissue (intracerebral hemorrhage) or bleeding in the subarachnoid space, which is the area between the protective layers of the brain and the brain's surface.[5] Hemorrhagic stroke is bleeding that occurs when blood vessels leading to the brain rupture. This happens due to a sudden increase in pressure within the brain, causing blocked blood vessels to be unable to withstand the pressure, leading to their rupture and subsequent bleeding.[6] Ischemic stroke occurs due to a blockage in the cerebral artery blood vessels and is often associated with several conditions, such as diabetes, hypertension, hypercholesterolemia, and smoking habits. In contrast, hemorrhagic stroke is caused by bleeding and frequently occurs due to hypertension in patients aged between 40 and 70 years.[7]

One of the issues faced by post-stroke patients is sensory-motor dysfunction. Sensory-motor impairments in these patients lead to balance disturbances, decreased flexibility of soft tissues, muscle weakness, and impaired sensory and motor control. These impairments result in the loss of several functions, including coordination, balance, and the ability to maintain body position.[8] Balance disturbances result in limitations in activities, reduced quality of life, and an increased risk of falls, which can lead to a higher likelihood of injury.[9] Balance maintains the center of gravity (COG) or center of mass over the base of support, whether in static or dynamic positions.[10] The balance variable is a vital evaluation or target that must be achieved for stroke patients undergoing rehabilitation or treatment programs. Many measurement tools, including the Romberg test, are available to assess static balance. Static balance is beneficial for maintaining a person's posture while at rest or in the initial position before initiating movement.[11] Therefore, static

balance needs to be measured to assess whether an individual can maintain their balance while at rest or when starting to move.

A measurement tool can be highly reliable if it produces consistent, stable results, even when administered to the same participants at different times.[12] A measurement tool is also said to have high validity if it provides measurement results that are precise and accurate.[13] Therefore, it is essential to assess the reliability and validity of a measurement tool to determine whether it can produce precise and accurate results. To evaluate static balance in stroke patients, a valid and reliable measurement tool is necessary to generate objective data, enabling appropriate management and treatment.

The Romberg test is a static balance test designed to identify specific abnormalities in patients with proprioceptive disorders by removing the visual and vestibular components involved in maintaining balance. This helps to identify neurological conditions related to proprioception.[14] The Romberg test has a sensitivity value of 0.61 and a specificity value of 0.58 in individuals over 40 with vestibular disorders.[15] According to a study by Teresa in 2008, the intraclass correlation coefficients (ICC) for the Romberg test related to Parkinson's disease were 0.84 with eyes closed and 0.86 with eyes open. Based on these ICC values, the Romberg test's reliability is considered very good for patients with Parkinson's disease.[16] However, the Romberg test's validity and reliability testing results concerning stroke are still minimal. In Indonesia, research on the validity and reliability of the Romberg test is scarce; therefore, this study aims to determine the validity and reliability of the test in post-stroke patients. This study hypothesizes that the Romberg test is valid and reliable for measuring static balance in stroke patients.

Methods

This study employed an observational research design with a methodological approach to determine the validity and reliability of the Romberg test for measuring static balance in stroke patients. The research was conducted at Pandan Arang Hospital in Boyolali from September to October 2024, with the population consisting of stroke patients. The independent variable in this study was static balance, while the dependent variables were the reliability and validity of the Romberg test.

Sampling was conducted using purposive sampling. Sample selection involved screening through a selection process based on inclusion and exclusion criteria. The inclusion criteria for this study were: 1) patients in the chronic phase of stroke, 2) aged 46 years and older, 3) able to stand without assistance, 4) able to communicate effectively, and 5) capable of understanding and following instructions. The exclusion criteria were: 1) history of musculoskeletal injuries, 2) presence of vertigo, 3) cardiovascular disorders, 4) coronary heart disease, 5) joint pain and instability that prevent the patient from standing, and 6) inability to communicate or follow instructions effectively. These conditions could affect the patient's balance, consequently influencing the test results. Additionally, these criteria were established to ensure patient safety and the accuracy of the research findings.

The total sample size for this study was 33 participants. According to Roscoe, as cited in Sugiyono (2015), an appropriate sample size for research typically ranges from 30 to 500.[17.] This study included two types of reliability testing: intra-rater and inter-rater reliability. Inter-rater reliability measurements were conducted by two raters simultaneously. The patient was instructed to stand with their feet together and arms crossed in front of their chest. The patient was then asked to open their eyes for 30 seconds, followed by the same position with their eyes closed for another 30 seconds. After a 15-minute interval, intra-rater reliability was assessed by having one rater repeat the test under the same conditions after the same interval.

To minimize bias in this study, the raters had specific procedures or steps to follow during the test. They practiced using a stopwatch to ensure they started the timer simultaneously at the same speed. A trial run was conducted before the test to help the patient adapt.

Data analysis in this study utilized univariate tests to describe patient characteristics in terms of mean, standard deviation (SD), minimum value, maximum value, and frequency (n). Normality tests were conducted on the measurements from rater 1 for test 1, rater 2 for test 1, and rater 1 for test 2, revealing a normal data distribution.

Next, validity testing of the Romberg test was performed using the Pearson Product Moment correlation between test 1 and test 2. The results were valid if $p < 0.05$ and/or r-obtained > r-table. Subsequently, reliability testing was conducted using Cronbach's alpha method to assess the consistency of the measurement tool. The interpretation of the results was as follows: $\alpha < 0.5$ indicates unacceptable reliability, $\alpha = 0.5 - < 0.6$ indicates poor reliability, $\alpha = 0.6 - < 0.7$ indicates questionable reliability, $\alpha = 0.7 - < 0.8$ indicates acceptable reliability, $\alpha = 0.8 - < 0.9$ indicates good reliability, and $\alpha \geq 0.9$ indicates excellent reliability.[18] The Intra-Class Correlation (ICC) was used to assess the agreement between two or more raters, with the results interpreted as follows: <0.5 indicates low reliability, 0.5–0.75 indicates moderate reliability, 0.75–0.90 indicates high reliability, and >0.90 indicates very high reliability.[19] This study was conducted with the approval of the Health Research Ethics Committee at RSUD Dr. Moewardi Surakarta, with approval number 1.362/V/HREC/2024.

Results

The target population for this study consisted of 55 stroke patients. Due to several limitations, the accessible population was reduced to 36 individuals. After applying the inclusion and exclusion criteria, the final number of research subjects who met the criteria was 33. A more detailed breakdown of the number of research subjects can be seen in Figure 1.

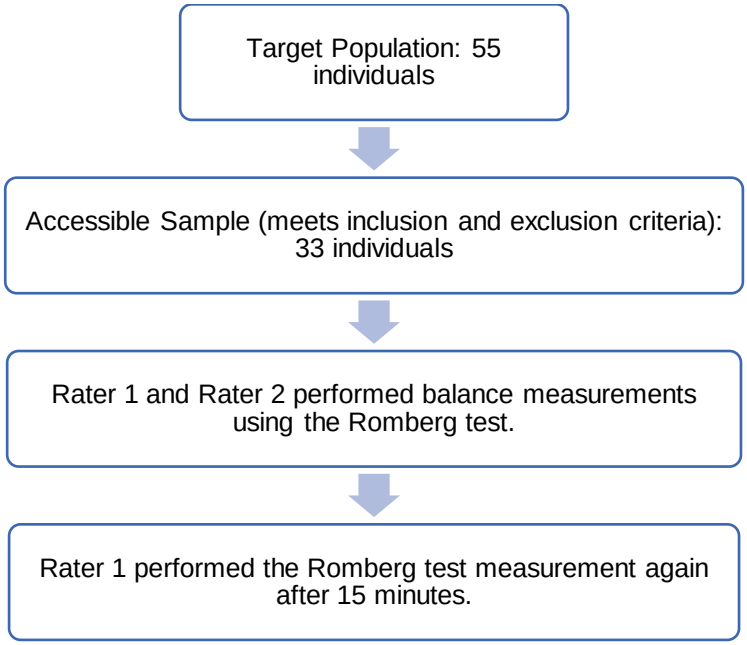

Figure 1. Research Flow

Based on Figure 1, it is evident that the total sample for this study consisted of 33 individuals. The general characteristics of the research subjects are presented in Table 1.

Table 1. Characteristics of Research Subject

Variable	Category	Number (n)	Percentage (%)	Mean ± SD	Min	Max
Age		33		61.73 ± 7.9	47	82
Gender	Male	19	57.6			
Female	14	42.4				
BMI	Underweight	3	9.1			
Normal	13	39.4				
Overweight	6	18.2				
Obese	11	33.3				
Side	Right	15	45.5			
Left	18	54.5				
Occupation	Retired	17	51.5			
Private Sector	8	24.2				
Housewife	7	21.2				
Farmer	1	3.0				
Duration		33		4.09 ± 1.8	1	8

Based on Table 1, most research subjects were male, with an average age above 60. The results showed that the proportion of subjects classified as having a regular Body Mass Index (BMI) was higher than those categorized as overweight and obese. The majority of stroke cases among the subjects were on the left side, and the average duration since the stroke was 4 years. The results of the correlation test between Test 1 and Test 2 of the Romberg Test can be seen in Table 2.

Table 2. Correlation Results Between Test 1 and Test 2 of the Romberg Test

Category	r Calculated	r Table	p Value
Eyes Open	0.947	0.333	<0.001
Eyes Closed	0.994		<0.001

Based on Table 2, the correlation test results between Test 1 and Test 2 using the Pearson Product Moment method indicate a p-value < 0.05. The results for both eyes open and eyes closed conditions show that r-hitung > r-tabel, confirming the validity of the Romberg test in stroke patients. The results of the Intra-Rater Reliability Test for the Romberg Test during the Eyes Open and Eyes Closed conditions can be seen in Table 3.

Table 3. Intra-Rater Reliability Results of the Romberg Test for Eyes Open and Eyes Closed

Category	Internal Consistency (Cronbach's Alpha)	Internal Consistency (Intra Class Correlation (ICC))
Eyes Open	0.973	0.947
Eyes Closed	0.997	0.994

Based on Table 3, the results indicate that the intra-rater reliability of the Romberg test for stroke patients has a Cronbach's Alpha and Intra-Class Correlation (ICC) for both eyes open and eyes closed conditions with $\alpha > 0.9$, indicating high consistency (excellent). This suggests that the same examiner can apply the Romberg test consistently.

The results of the inter-rater reliability test for the Romberg test during the eyes-open and eyes-closed conditions can be seen in Table 4.

Table 4. Inter-Rater Reliability Results of the Romberg Test for Eyes Open and Eyes Closed

Category	Internal Consistency (Cronbach's Alpha)	Internal Consistency (Intra Class Correlation (ICC))
Eyes Open	1.000	1.000
Eyes Closed	1.000	1.000

Based on Table 4, the results indicate that the inter-rater reliability of the Romberg test for stroke patients has a Cronbach's Alpha and Intra-Class Correlation (ICC) for both eyes open and eyes closed conditions with $\alpha > 0.9$, indicating high consistency (excellent). This suggests that the Romberg test can be applied consistently by different examiners.

Discussion

Based on Table 1, the average age of stroke patients is above 60 years, with a minimum age of 47 years and a maximum of 82 years. Stroke typically occurs in individuals over 50 years old due to the hardening or stiffness of blood vessels due to aging. This condition causes the heart to work harder, leading to high blood pressure and increasing the risk of stroke. Additionally, it is noted that most subjects in this study are male. This finding aligns with a literature review that reported a higher incidence of stroke in males (53.9%) compared to females (46.04%). This disparity may be attributed to lifestyle factors, as men often engage in behaviors such as smoking and alcohol consumption, which can adversely affect their health and elevate the risk of stroke.[20]

The impact of stroke depends on the area of the brain affected, whether on the right or left side. This influences the condition of post-stroke patients, leading to conditions such as paralysis on one side of the body (hemiplegia) or muscle weakness on the affected side (hemiparesis). Additionally, stroke patients often experience balance issues due to decreased muscle mobility, which reduces their ability to maintain bodily balance.[21]

Balance issues pose an additional challenge for post-stroke patients. Numerous studies have shown that these balance disturbances are a significant risk factor for falls and fear of falling. As a result, fall-related injuries are expected to increase, which, in turn, may elevate mortality rates among stroke survivors.[22] Balance is maintained through a sensorimotor control system that involves input from vision, proprioception (touch), and the vestibular system. This input is then processed to produce appropriate movements of the eyes and body muscles.[22]

An effective balance system allows a person to see clearly while moving, to understand their body's position relative to gravity, and to regulate direction, speed, and posture to maintain stability during various activities.[23] Static balance is crucial for stroke patients as it plays a significant role in maintaining postural stability while standing, sitting, and before initiating movement, thereby reducing the risk of falls. Therefore, a reliable and valid measurement tool is necessary to evaluate the effectiveness of treatments or rehabilitation for stroke patients in assessing their static balance capabilities.

Stroke patients often experience a decline in static balance, necessitating rehabilitation. One of the rehabilitation goals is to improve static balance; however, to assess the effectiveness of any treatment, a measurement tool is required for evaluation, such as the Romberg test. As demonstrated in a study by Kadek et al. (2024), the Romberg test is used as a measurement tool to evaluate balance following physiotherapy management in patients with hemiparetic stroke.[24] The results of this study support the use of the Romberg test in assessing the effectiveness of rehabilitation interventions in stroke patients. The Romberg test has also undergone psychometric testing in various conditions, such as in patients with Parkinson's disease, where it demonstrated values of 0.84 with eyes closed and 0.86 with eyes open. Based on the Intra Class Correlation (ICC) values, the reliability of the Romberg test is excellent for patients with Parkinson's disease.[25]

Intra-rater reliability involves the repeated assessment of static balance using the Romberg test conducted by a single rater, where the patient is asked to perform the same test again after a 15-minute interval. In this study, the internal consistency reliability (Cronbach's alpha) was found to be 0.947 for eyes open and 0.994 for eyes closed, indicating very high internal consistency. The ICC values demonstrated excellent intra-rater reliability, with scores of 0.973 for eyes open and 0.997 for eyes closed. This suggests that the Romberg test, when repeated by the same rater, yields a high level of consistency.

Inter-rater reliability refers to the static balance test using the Romberg test conducted by two raters simultaneously. The results of the inter-rater reliability testing in this study showed an internal consistency (Cronbach's alpha) of 1.000 for both eyes open and eyes closed, indicating high internal consistency. Furthermore, the ICC values for both eyes open and closed were also 1.000, suggesting high reliability (excellent) and indicating that different examiners can consistently apply the Romberg test.

The validity results, evaluated using the Pearson Product Moment correlation, showed significant findings ($p < 0.001$). The calculated r-values were more critical than 0.9, with $r = 0.947$ for eyes open and $r = 0.994$ for eyes closed. Thus, it can be concluded that the Romberg test possesses very high validity, as the R-values exceed the critical value (r-table = 0.333) for both eyes open and closed tests, based on a sample size of 33 individuals.

These findings align with several studies that have evaluated the validity and reliability of the Romberg test across different populations. A systematic review reported excellent inter-rater reliability for subjective ($k = 0.86–1.00$) and objective measures (ICC = 0.91–0.99).[26] These findings demonstrate a high level of consistency in the research conducted among different raters. Additionally, it was found that the Romberg test has good discriminative validity, effectively differentiating between healthy individuals and patients with neurological conditions.[27]

Based on the results of this study, the Romberg test can be considered valid and reliable as a measure of static balance in stroke patients. Thus, the objective of this research, which was to determine the validity and reliability of the Romberg test as a tool for assessing static balance in stroke patients, has been achieved. However, the applicability of the Romberg test to patients with other neurological disorders, such as Alzheimer's disease or Parkinson's disease, may be limited, even though they may experience similar balance issues. This limitation arises from differences in the underlying causes, lesion locations, and associated sensory or motor impairments.

This study also has several limitations. First, the sample size at Pandan Arang Hospital in Boyolali was limited; future research should aim to increase the sample size and expand the geographic scope beyond a single location. Second, some research subjects struggled to follow instructions effectively due to various limitations, which could have affected the test results. Third, time constraints may have influenced the patient's desire for a quicker process to return home. Finally, there is potential for rater bias due to subjective influences.

Conclusion

This study demonstrates that the Romberg test is a valid and reliable tool for assessing static balance in stroke patients. The analysis results indicate high consistency in intra-rater and inter-rater reliability and significant validity. Although the Romberg test is practical for stroke patients, its results may not be generalizable to populations with other neurological disorders due to differences in causes and characteristics of impairments.

The limitations of this study include limited sample size, difficulties subjects face in following instructions, time constraints, and potential rater bias. Therefore, it is recommended that future research expands the sample and location to enhance the reliability of results and consider other variables that may affect balance.

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