



EFFECT OF PROM AND HAND GRIP BALL EXERCISE IN STROKE PATIENT WITH LEFT HEMIPARESIS : A CASE REPORT

Ridha Ghina Nurjanah¹, Popon Haryeti²

^{1,2}Nursing Professional Study Program, Universitas Pendidikan Indonesia Sumedang Campus, Indonesia
ridhaghina@upi.edu, poponharyeti@upi.edu

Abstract

Hemiparesis is a common complication after stroke that causes decreased muscle strength and mobility. This condition becomes more complex when accompanied by comorbid diseases such as Systemic Lupus Erythematosus (SLE), thus requiring a more integrated rehabilitation approach. This study aims to provide the effect of a combination of Passive Range of Motion (PROM) training and finger grip ball training on increasing muscle strength in infarction stroke patients with left hemiparesis and SLE comorbidity. The intervention was carried out in the stroke unit for four consecutive days, twice a day, with a duration of 20 minutes of PROM and 7–10 minutes of finger grip ball training each session. Muscle strength assessment was carried out using the Manual Muscle Testing (MMT) Scale before and after the intervention. The results showed that before therapy, the strength of the left extremity muscles was at a minimal contraction level (score 1/5), and increased to being able to perform active movements against moderate resistance (score 4/5) after the intervention. During therapy, no side effects were found, and the patient was able to tolerate the exercise well. These findings support that the combination of PROM and finger grip ball exercises can be an effective and safe non-pharmacological rehabilitation strategy to improve muscle strength in Ny. R stroke patients with hemiparesis and SLE comorbidity.

Keywords: PROM, Hand Grip Ball, Infarct Stroke, SLE

Abstrak

Hemiparesis merupakan komplikasi umum pasca-stroke yang menyebabkan penurunan kekuatan dan mobilitas otot. Kondisi ini menjadi lebih kompleks apabila disertai penyakit komorbid seperti Lupus Eritematosus Sistemik, sehingga memerlukan pendekatan rehabilitasi yang lebih terintegrasi. Studi ini bertujuan untuk mengevaluasi pengaruh kombinasi latihan Passive Range of Motion (PROM) dan latihan bola genggam jari terhadap peningkatan kekuatan otot pada pasien stroke infark dengan hemiparesis sinistra dan komorbid LES. Intervensi dilakukan di unit stroke selama empat hari berturut-turut, dua kali sehari, dengan durasi 20 menit PROM dan 7–10 menit latihan bola genggam jari setiap sesi. Penilaian kekuatan otot dilakukan menggunakan skala Manual Muscle Testing (MMT) sebelum dan sesudah intervensi. Hasil menunjukkan bahwa sebelum terapi, kekuatan otot ekstremitas kiri berada pada tingkat kontraksi minimal (skor 1/5), dan meningkat menjadi mampu melakukan gerakan aktif melawan resistensi sedang (skor 4/5) setelah intervensi. Selama terapi, tidak ditemukan efek samping, dan pasien mampu mentoleransi latihan dengan baik. Temuan ini mendukung bahwa kombinasi PROM dan latihan bola genggam jari menjadi strategi rehabilitasi nonfarmakologis yang efektif dan aman untuk meningkatkan kekuatan otot pada Ny.R pasien stroke dengan hemiparesis dan LES.

Kata Kunci: PROM, Genggam Bola Jari, Stroke Infark, LES

@Jurnal Ners Prodi Sarjana Keperawatan & Profesi Ners FIK UP 2025

✉ Corresponding author :

Address : Jl. Desa Licin, Licin, Kec. Cimalaka, Kabupaten Sumedang, Jawa Barat 45353

Email : ridhaghina@upi.edu, poponharyeti@upi.edu

Phone : 082118688845

INTRODUCTION

Stroke is a neurological disorder marked by a sudden decline in brain function, presenting with focal or global symptoms that persist for more than 24 hours or lead to death without any other cause besides vascular disturbances. According to the World Health Organization (WHO, 2025). Stroke is the second leading cause of death globally and the third leading cause of combined disability and mortality. Based on the Global Burden of Disease Study Feigin et al (2022) stroke cases have increased significantly—new stroke cases rose by 70%, deaths by 43%, prevalence by 102%, and disability burden by 143% globally. Notably, 86% of stroke deaths and 89% of stroke-related disabilities occur in low- and middle-income countries, particularly in Eastern Europe, Asia, and Sub-Saharan Africa.

In Indonesia, stroke remains the leading cause of death and disability. The 2023 Indonesian Health Survey (SKI) reports a national stroke prevalence of 8.3 per 1000 people, a slight decrease from 10.9 per 1000 in 2018. West Java is among the top provinces with the highest stroke prevalence, approximately 10%, alongside Jakarta (10.6%), East Kalimantan (10%), and Yogyakarta (11.4%). Stroke most frequently affects individuals aged over 75 years (41.3%), while it is least common among those aged 15–24 years (0.1%) (BKPK, 2023).

A common complication of stroke is hemiparesis, affecting approximately 70–80% of stroke survivors. Hemiparesis is characterized by weakness on one side of the body and significantly impacts patients' ability to perform daily activities such as walking, grasping, and self-care (McDonnell et al., 2021). Without early intervention, muscle disuse can lead to joint contractures, muscle atrophy, and loss of function. These risks are exacerbated when stroke is accompanied by comorbid conditions such as systemic lupus erythematosus (SLE), an autoimmune disease known to affect the musculoskeletal and nervous systems, thereby complicating stroke recovery.

To address these issues, non-pharmacological interventions such as passive range of motion (PROM) exercises and hand grip ball training are recommended. PROM exercises help maintain joint flexibility and prevent contractures in immobilized patients (Smith et al., 2022). Meanwhile, hand grip ball exercises stimulate neuromuscular responses and improve upper limb strength and sensory function. The use of textured grip balls can provide additional proprioceptive and tactile stimulation, which is beneficial in neurorehabilitation (Lee & Choi, 2021; Hentu et al., 2020).

Previous studies have shown the positive effects of a combination of PROM and handheld

ball exercises in improving muscle strength in post-stroke patients. For example, Asmawita et al (2022) reported a significant increase in muscle strength in upper and lower extremity strength from grades 2 to 3, while Christaputri & Anam (2023) found that textured balls were more effective than smooth balls in improving motor function.

This study aims to examine the effects of combining PROM and hand grip ball exercise on muscle strength improvement in a stroke patient with left hemiparesis and comorbid SLE. The intervention is designed based on evidence-based nursing practice to optimize motor recovery, prevent complications, and improve quality of life.

The findings of this study are expected to provide clinical insights for nurses and rehabilitation practitioners in selecting effective and practical interventions for stroke rehabilitation, particularly in patients with complex comorbidities. It also highlights the role of integrative nursing care in achieving functional recovery and preventing long-term disability.

METHOD

The study was conducted using a case study method with a nursing care approach that applies evidence-based practice. This approach was applied to one patient as the focus of the patient being managed, namely a stroke infarction patient with hemiparesis and comorbid systemic lupus erythematosus who was treated in the stroke unit of Umarwirahadikusumah Sumedang Hospital on November 12-17, 2024. The inclusion criteria for providing PROM and finger grip ball therapy interventions were patients who had conscious awareness, were cooperative, did not experience total aphasia and severe dysphagia, and did not experience severe ataxia or neurodegenerative diseases. The data collected in this case study were analyzed using thematic data analysis techniques from the beginning of the assessment to the end of the evaluation. The assessment format used medical surgical nursing care at the Indonesian Education University, Sumedang Regional Campus. The implementation of the intervention systematically began with making a time contract with the patient and family, then the patient was given a comprehensive and detailed explanation regarding the intervention to be given. This explanation aims to provide an understanding of the purpose of the intervention action to be carried out. After that, the patient will be given a consent form, then the patient fills it out as a sign of the patient's consent to undergo intervention with the patient's family present as witnesses. After that, the researcher provides an explanation of the steps of each intervention action that will be carried out to the patient, as well as providing equipment for the continuation of the intervention action. Data collection in this study

used Manual Muscle Testing (MMT), an instrument used to measure the level of muscle strength in patients both before and after the intervention action. The scale (MMT) consists of 6 assessment points, referring to (Roman et al., 2022).

Table 1. Manual muscle testing scoring system

Grade	Description	Criteria
0	No Contraction	No contraction can be felt in the muscle
1	Trace muscle contraction	Muscle contraction can be felt on palpation but without motion
2	Poor muscle contraction	Muscle contraction and motion of the segment in a gravity discarded position (gravity minimized)
3	Muscle contraction	Full motion of the segment against gravity
4	Good muscle contraction	Full motion of the segment against gravity and moderate resistance
5	Normal muscle contraction	Full motion of the segment against gravity and maximal resistance

The intervention was given to the patient through several stages: (1) preparing the patient's position to start the exercise and (2) performing PROM starting from the upper extremities, starting from the tip (distal) to the proximal, then continuing to the extremities starting from the bottom of the foot to the thigh. (3) Providing rest time, (4) Preparing a serrated rubber ball as a tool for finger grip ball therapy, (5) Providing finger grip ball therapy by giving gripping instructions to the patient. (6) After being given both interventions, the researcher conducted a re-evaluation using the MMT scale.

The implementation of this intervention was carried out with an intensity of twice a day for four consecutive days. The intervention was carried out in the morning after breakfast and in the afternoon, with a duration of 20 minutes for PROM and 7-10 minutes for finger grip ball. After the implementation of the intervention, the researcher conducted an evaluation by re-measuring muscle strength using the MMT scale to determine the comparison between before and after administration.

This case study has passed the ethical test of the Health Research Ethics Committee of the Faculty of Health Sciences and Technology, Universitas Jenderal Achmad Yani Cimahi, with a decree number of 07/KEPK/FITKes-Unjani/V/2025.

RESULTS AND DISCUSSION

Nursing care was provided to Mrs. R, 28 years old with a vocational high school education,

and a housewife. She first came on Sunday, November 11, 2024 with complaints of weakness in the left extremities since 2 days before being admitted to the hospital, complaints had been felt for the first time since 2 weeks ago. Weakness was increasingly severe starting from the feet spreading to the hands accompanied by numbness, adequate patient contact examination, no complaints of rero, pero and seizures. The patient has a history of recurrent ischemic stroke (2014, 2021, 2023 3 times, 2024 2 times), a history of Systemic Lupus Erythematosus (SLE) since 2012, currently on cyclophosphamide therapy cycle 2.

Physical assessment was conducted on November 12, 2024. During the assessment, the client appeared weak, but was still in a state of compos mentis consciousness (E4V5M6). Vital signs were within normal limits with blood pressure of 130/80 mmHg, pulse rate of 86x/minute, respiration rate of 20x/minute, temperature of 36.7°C, and SpO2 of 97%. In the musculoskeletal system there was weakness in the upper and lower left extremities, with a muscle strength value of 1/5 and the right extremity showed no weakness with a value of 5/5. Supporting examinations such as laboratory and imaging did not show new pathological results. Non-contrast head CT scan showed multiple lacunar infarcts in the right pons and left basal ganglia, without evidence of hemorrhage or intracranial mass. MRI and MRA showed no acute infarction or large vessel abnormalities.

Table 2. laboratory results in 13 November 2024

Examination names	Result	Normal value	Unit
Hemoglobin	11.7	12.3 – 15.3	g/dL
Leukosit	7,210	4,500 – 10,000	/mm3
Trombosit	236,000	150,000 – 450,000	/mm3
Hematocrit	36.6	35 – 47	%
Creatinin	0.53	0.5 – 1.1	mg/dL
Total Cholesterol	14.4	11.0 – 23.0	mg/dL
Trigliserida	76	< 200	mg/dL
HDL-cholesterol	52	> 35	mg/dL
LDL-cholesterol	95	< 150	mg/dL
Gout	2.3	< 5.7	mg/dL
Random blood glucose test	81	100 - 150	mg/dL

Picture 1. Serrated Rubber Ball



Drug therapy given to patients during treatment is: infusion of Methylprednisolone 500 mg in Nacl 0.9% 100cc drip 1 hour, Omeprazole 40mg/12 hours, Ondansetron 4mg/12 hours, Sucralfate 500mg tablet/8 hours, Hydroxycloquine 400mg tablet/24 hours, Mycophenolate Mofetil 500mg tablet/12 hours, bisoprolol 1.25 mg tablet/24 hours, kamyfet 1000mg tablet/12 hours, atorvastin 20mg tablet/24 hours.

The diagnosis of primary bleeding that was established was impaired physical mobility with neuromuscular disorders characterized by weakness in the left extremity with an MMT value of 1 out of 5. Although the patient had received medical treatment in the process of stroke recovery with left hemiparesis, the patient required additional non-pharmacological therapy to improve motor function. This is important to help patients improve their quality of life.

The provision of Passive range of motion and finger grip ball interventions was carried out twice a day for four consecutive days, which took place from November 13 to November 16, 2024 in the stroke unit (Anyelir) ward of Wirahadikusumah General Hospital in Sumedang.

The results showed an increase in muscle strength in Mrs. R on the last day of evaluation on November 17, 2024, namely, from a value of 1 to 4 on the MMT scale.

Table 3. MMT value evaluation results

Intervention time	MMT Evaluation Value After Intervention		Duration of intervention	
	Upper extremities	lower extremities	PROM	finger grip ball
Day-1	1/5	1/5	20'	7-10'
Day-2	3/5	2/5	20'	7-10'
Day-3	4/5	4/5	20'	7-10'
Day-4	4/5	4/5	20'	7-10'

Nursing care for Mrs. R illustrates the complexity of managing recurrent stroke patients with systemic autoimmune comorbidities, namely Systemic Lupus Erythematosus (SLE). Weakness

in the upper and lower left extremities with a Manual Muscle Testing (MMT) value of 1/5 indicates impaired physical mobility due to central motor nerve damage, which is reinforced by CT scan results showing lacunar infarction in the pons and basal ganglia areas. Recurrent strokes, especially the lacunar type, are known to cause long-term motor disability (Caplan, 2015).

Infarction stroke occurs due to occlusion of blood vessels in the brain which causes ischemia of brain tissue (Rehman et al., 2024). One type of infarction that often occurs is lacunar infarction. Lacunar infarction is one of the most common types of infarction stroke, with a prevalence reaching around 45% of all cases of infarction stroke in the national registry (Harris et al., 2018). Lacunar infarction stroke is a stroke that occurs due to occlusion of small penetrating arteries that supply structures in the brain such as the internal capsule, thalamus and brainstem. This infarction is usually caused by lipohyalinosis or micro-atherosclerosis due to chronic hypertension. Infarction that occurs in one hemisphere will cause symptoms on the opposite side of the body, one of which is unilateral limb weakness (hemiparesis). Hemiparesis that occurs on the left side of the body is caused by infarction in the right hemisphere of the internal capsule due to damage to the corticospinal pathway which plays a role in voluntary motoric movements (Rehman et al., 2024).

The process of infarction stroke begins with decreased cerebral perfusion which causes failure in producing energy (ATP), increased glutamate release (excitotoxicity), and oxidative stress, followed by inflammation and nerve cell death through apoptosis or necrosis. The resulting hemiparesis results in impaired physical mobility characterized by muscle weakness and limitations in performing daily activities (Salaudeen et al., 2024).

SLE also worsens this condition through chronic inflammation that attacks the musculoskeletal system and peripheral nerves (Bortoluzzi et al., 2019). Pathophysiologically, SLE is characterized by the formation of autoantibodies from immune complexes that cause chronic inflammation in various organs, including the central nervous system (Hanly et al., 2019). The combination of structural neurological factors due to stroke and systemic disorders from SLE worsens the patient's physical mobility status. SLE is triggered by vasculitis or inflammation of the blood vessel walls that occurs in the walls of small and medium blood vessels, thus disrupting blood flow to peripheral tissues (Pyrpasopoulou et al., 2012). In addition, endothelial dysfunction can occur due to an increased risk of atherosclerosis, resulting in impaired peripheral perfusion (Fanouriakis et al., 2019). Therefore, the focus of nursing care is directed at interventions that can

improve motor function gradually and safely through an evidence-based practice approach, namely Passive Range of Motion (PROM) exercises and finger ball grip exercises, as part of mobilization support interventions (SIKI: I.05173).

The PROM exercise intervention was carried out for 20 minutes and finger ball grip exercises for 7 to 10 minutes, with a duration of two times per day for four consecutive days. The evaluation used to measure muscle strength and range of motion of the extremities using Manual Muscle Testing (MMT) which showed an increase in left extremity muscle strength from 1/5 to 4/5. These results are in line with research from Hentu et al (2020) that there was a significant increase in muscle strength with a comparison of the control group that the combination of ROM exercises and the use of rubber balls was effective in increasing the strength and grip function of stroke patients with hemiparesis. In addition, Putri & Noer (2024) stated that the combination of ROM exercises and rubber ball grips in stroke patients passively with 10 meetings showed an increase with an average from a scale of 2 to a scale of 4.

Range of motion is an exercise performed to maintain or improve the level of perfection of normal and complete joint movement ability to increase muscle mass and tone. Passive range of motion can be applied as one of the rehabilitation to maintain and preserve joint range of motion (Indrawati, 2020). PROM is a movement where the energy expended for exercise comes from other people or mechanical devices. Nurses perform passive movements on patients involving joints according to the normal range of motion, the muscle strength used in the movement is 50%. The joints moved during PROM are all joints of the body or only on the affected body parts and the patient cannot do it independently (Agusrianto & Rantesigi, 2020). In this study, PROM intervention was carried out for 20 minutes with two sessions in one day for four consecutive days. This is in accordance with research conducted by Agusrianto and Rantesigi (2020). where the application with a time of 15-20 minutes with 8 repetitions of movements for 2 sessions per day can increase or maintain flexibility and muscle strength, maintain heart and respiratory function, prevent stiffness in joints, stimulate blood circulation and prevent deformities and contractures in stroke patients. This study is also in line with Basri et al., (2024) which stated that PROM exercise in patients with type 2 diabetes mellitus provided a significant increase in blood circulation in the extremities, from an average value of 1.28 to 1.94 ($p = 0.000$). Although not directly in stroke patients, these results show the potential of PROM in increasing tissue perfusion in general.

Researchers provided finger ball grip exercises using rubber balls with a serrated surface that were soft and flexible to Mrs. R. In addition,

there was additional sensory feedback if the patient gripped firmly. Christaputri and Anam (2023) found that serrated rubber balls were more effective than balls without texture in increasing upper limb motor strength in patients with infarction stroke. Gripping exercises with a serrated rubber ball provide additional stimulation to sensory and neuromuscular receptors, accelerate muscle contractions and improve patient motor control (Karim & Syamsuddin, 2025). Dwi et al. (2024) showed that grip exercises with serrated rubber balls significantly increased upper limb muscle strength in stroke patients. The mechanism of action involves activation of the cerebral cortex and cerebellum, which triggers motor responses, and stimulates muscle fibers to contract effectively. The characteristics of the ball that is flexible and has a serrated surface stimulate sensory and motor skills during exercise. Auditory feedback from the sound of the ball when held also serves as a motivator to increase patient participation (Febrywati et al., 2023).

The combination of PROM exercises and rubber ball gripping with a serrated texture has been shown to accelerate neuromuscular recovery and hand function in post-stroke patients. During the intervention, the patient's condition remained stable without complaints of pain or disturbances in vital signs, indicating that this approach is safe to apply. This is in line with the principles of evidence-based practice (EBP) which prioritize effectiveness and safety in homicide practice (Wade, 2020)

Thus, the combination of PROM exercises and rubber ball gripping has a significant effect on increasing muscle strength in Mrs. R, a stroke infarction patient with left hemiparesis and comorbid SLE. This intervention is an effective, innovative, and safe rehabilitation strategy to improve motor function while preventing complications due to immobilization. Therefore, this intervention is worthy of being recommended as part of an integrated nursing rehabilitation program, taking into account the tolerance and clinical conditions of each patient

CONCLUSION

Based on the findings and discussion of the case report on Mrs. R, a patient with a history of recurrent infarct stroke and comorbid Systemic Lupus Erythematosus (SLE), it can be concluded that the combination of Passive Range of Motion (PROM) technique and finger grip ball exercise has a significant effect on increasing muscle strength of the left extremity with hemiparesis. Implementation of the intervention for 4 consecutive days, twice a day, each with a duration of 20 minutes of PROM and 7-10 minutes of ball grip exercise, showed an increase in muscle strength from MMT value 1/5 to 4/5.

These results indicate that non-pharmacological interventions based on evidence-based practice are effective as nursing rehabilitation strategies to improve mobility function in Mrs. R, prevent complications due to immobilization, and support patient independence. The success of therapy is also supported by the stability of the patient's general condition.

REFERENCES

- Abdullahi, A., Wong, T. W. L., & Ng, S. S. M. (2025). Effects of passive movement on motor function and disability in patients with stroke: A systematic review and meta-analysis. *Journal of Functional Morphology and Kinesiology*, 10(2), 117. <https://doi.org/10.3390/jfmk10020117>
- Asmawita, H., Ahyana, & Kamal, A. (2022). Kombinasi Latihan ROM dan Bola Karet Pada Pasien Stroke Iskemik Dengan Hemiparesis: Suatu Studi Kasus. *JIM FKep*, 1(3), 108–113.
- Badan Kebijakan Pembangunan Kesehatan. (2023). SKI 2023 Dalam Angka. *Kementrian Kesehatan RI*, 1–68.
- Basri, B., Arlis, A., & Yongki, P. (2024). Effect of Lower Extremity Range of Motion (ROM) Exercise on Improving Blood Circulation. *Jurnal Keperawatan Priority*, 7(2), 87–97. <https://doi.org/10.34012/jukep.v7i2.5414>
- Bortoluzzi, A., Scirè, C. A., & Govoni, M. (2019). Peripheral nervous system involvement in systemic lupus erythematosus: A review of clinical features and mechanisms. *Clinical and Experimental Rheumatology*, 37(6), 1000–1007. <https://www.clinexprheumatol.org/article.asp?a=12326>
- Caplan, L. R. (2015). Lacunar infarction and small vessel disease: Pathology and pathophysiology. *Journal of Stroke*, 17(1), 2–6. <https://doi.org/10.5853/jos.2015.17.1.2>
- Christaputri, S. T. W., & Anam, A. (2023). Perbandingan Implementasi Terapi Genggam Bola Karet Bergerigi dan Tidak Bergerigi pada Pasien Stroke Nonhemoragik terhadap Peningkatan Kekuatan Motorik Ekstremitas Atas. *Ners Muda*, 4(3), 351–357.
- Dwi, F., Dodik, C., & Alwin, H. (2024). Pengaruh Latihan Genggam Bola Karet Gerigi Terhadap Peningkatan Kekuatan Otot Ekstremitas Atas Pada Pasien Stroke Di Desa Brabe (Studi Di Maron Probolinggo). 3, 155–165. <https://journal.mandiracendikia.com/index.php/JIK-MC/article/download/1350/1086/9227>
- Feigin, V. L., Brainin, M., Norrving, B., Martins, S., Sacco, R. L., Hacke, W., Fisher, M., Pandian, J., & Lindsay, P. (2022). World Stroke Organization (WSO): Global Stroke Fact Sheet 2022. *International Journal of Stroke*, 17(1), 18–29. <https://doi.org/10.1177/17474930211065917>
- Hentu, M. T., Rochmawati, E., & Firmawati, F. (2020). Efektivitas Latihan Range of Motion (ROM) dengan Bola Karet terhadap Kekuatan dan Fungsi Genggam pada Pasien Stroke. *Jurnal Ilmu Kesehatan*, 8(2), 112–118.
- Karim, F. R., & Syamsuddin, F. (2025). Perbandingan efektivitas pemberian terapi bola karet bergerigi dan tidak bergerigi dengan kekuatan otot genggam tangan pasien stroke non hemoragik di Ruang Neuro RSUD Prof. Dr. H. Aloei Saboe Kota Gorontalo. *Jurnal Keperawatan Muhammadiyah*, 10(1), 9–15. <http://journal.um-surabaya.ac.id/index.php/JKM/article/view/24878>
- Lee, S. H., & Choi, Y. J. (2021). Effects of Hand-Grip Ball Exercise on Hand Function and Upper-Limb Strength in Stroke Patients. *Journal of Physical Therapy Science*, 33(6), 428–433. <https://doi.org/10.1589/jpts.33.428>
- McDonnell, M. N., Hillier, S. L., & Eng, J. J. (2021). Motor Recovery After Stroke: Implications for Rehabilitation. *Stroke Rehabilitation Journal*, 38(5), 347–354. <https://doi.org/10.1682/JRRD.2021.06.0071>
- Putri, K., & Noer, I. (2024). Application of Passive Range of Motion (ROM) Exercises on Increasing Muscle Strenght in Ischemik Stroke Patiens in Sultan Fatah Demak. 129–134.
- Roman, N. A., Miclaus, R. S., Nicolau, C., & Sechel, G. (2022). Customized Manual Muscle Testing for Post-Stroke Upper Extremity Assessment. *Brain Sciences*, 12(4). <https://doi.org/10.3390/brainsci12040457>
- Smith, L. J., Brown, K. J., & White, D. A. (2022). Passive Range of Motion and Functional Outcomes in Stroke Rehabilitation. *Journal of Neurologic Physical Therapy*, 46(2), 93–99. <https://doi.org/10.1097/NPT.0000000000000376>
- Suprpto, S., Mulat, T. C., Asmi, A. S., & Muridah, M. (2023). Penerapan Range of Motion Pada Pasien Stroke Dengan Gangguan Mobilitas Fisik Penerbit : Edukasi Ilmiah Indonesia. *Jurnal Edukasi Ilmiah Keshatan*, 1(2).
- Wade, D. T. (2020). What is rehabilitation? An empirical investigation leading to an evidence-based description. *Clinical Rehabilitation*, 34(5), 571–583. <https://doi.org/10.1177/0269215520905112>
- WHO. (2025). WHO EMRO | Stroke, Cerebrovascular accident | Health topics. World Health Organization.

<https://www.emro.who.int/health-topics/stroke-cerebrovascular-accident/index.html>