

THE EFFECT OF PASSIVE KNEE FLEXION RANGE OF MOTION (ROM) EXERCISES ON LOWER EXTREMITY MUSCLE STRENGTH IN POST-STROKE PATIENTS

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ABSTRACT

The high incidence of stroke in Indonesia is a concern because it can cause lower extremity muscle weakness which impacts on decreasing patient mobility. One rehabilitation intervention that can increase lower extremity muscle strength is ROM *Knee Flexion exercise*. This study aims to prove the effectiveness of ROM *Knee Flexion exercise* on increasing lower extremity muscle strength in post-stroke patients. The study used a pre-experimental design with a one-group pre-test and post-test approach. The study was conducted at the Medical Rehabilitation Clinic of Sumberglagah Regional Hospital in May 2026 with a sample of 35 respondents selected using a total sampling technique. The research instruments were SOP ROM *Knee Flexion exercise* and MMT observation sheet. Muscle strength measurements were carried out by MMT on the 1st day before the intervention (pre-test) and the 5th day after the administration of ROM *Knee Flexion exercise* (post-test). The results showed that 34 respondents (97.1%) experienced an increase in muscle strength after being given ROM *Knee Flexion exercise*, while 1 respondent (2.9%) did not experience an increase. The analysis results using the Wilcoxon Signed Rank Test showed a p-value of $0.000 < \alpha 0.05$, which means there was a significant difference between muscle strength before and after the intervention. It was concluded that ROM *Knee Flexion exercises* were effective in increasing lower extremity muscle strength in post-stroke patients.

Keywords: *Stroke, Knee Flexion ROM, Muscle Strength*

INTRODUCTION

Stroke is a neurological disorder caused by the interruption of blood flow to the brain, either due to a blockage or hemorrhage, which significantly impacts the sufferer's quality of life physically, psychologically, socially, and functionally (Kuriakose & Xiao, 2020). Stroke is known as one of the leading causes of long-term disability because it causes impaired motor, sensory, and cognitive function, limiting an individual's ability to perform daily activities independently (WHO, 2023). In 2021, Azzollini et al. reported that motor impairment is the most common problem in stroke patients, especially in the upper and lower extremities, characterized by muscle weakness, decreased muscle tone, and impaired coordination. Lower extremity muscle weakness in post-stroke patients directly impacts mobility abilities such as walking, standing, changing positions, and maintaining body balance. Therefore, this condition is a critical issue in the rehabilitation process for post-stroke patients, requiring effective interventions to improve lower extremity muscle strength and patient independence.

The prevalence of stroke continues to increase every year and is the second leading cause of death and the leading cause of disability in adults worldwide (WHO, 2023). In Indonesia, the prevalence of stroke increased from 7% in 2013 to 10.9% in 2018 based on the 2018 Basic Health Research (Riskesdas). In East Java Province, the incidence of stroke is high and places a significant burden on health services, especially medical rehabilitation.

This is in line with the results of a preliminary study at Sumberglagah Regional Hospital which showed that most post-stroke patients experience decreased lower extremity muscle strength and therefore require assistance in carrying out daily activities. Based on the results of a preliminary study conducted at the Medical Rehabilitation Polyclinic in February 2026, Based on a preliminary study conducted on 5 post-stroke patients during the initial visit, it was found that most experienced decreased lower extremity muscle strength. In addition, 4 of the 5 patients were known to have never done *Knee Flexion exercises* independently with family assistance at home, while 1 patient understood but had not done it regularly.

Decreased muscle strength in post-stroke patients occurs due to motor neuron damage due to disrupted blood supply to the brain, resulting in suboptimal nerve impulse transmission and the inability of muscles to contract optimally (Kuriakose & Xiao, 2020). Furthermore, prolonged immobilization can cause muscle atrophy, decreased tone, and joint stiffness, potentially leading to contractures (Azzollini et al., 2021). This condition can reduce the patient's level of independence and increase dependence on family and healthcare professionals. If rehabilitation is not carried out routinely and continuously, complications such as decreased lower extremity muscle strength, impaired balance, and limited mobility will increase, slowing the recovery process for post-stroke patients.

One intervention that can be performed to increase muscle strength is passive Range of Motion (ROM) exercises, specifically *Knee Flexion movements* given to patients who are unable to move their extremities independently with the help of nurses or family (Rahmadani & Rustandi, 2019). Passive ROM exercises not only aim to maintain joint flexibility but can also be used as an intervention to increase lower extremity muscle strength by stimulating repeated muscle contractions and increasing blood flow to muscle tissue. Passive *Knee Flexion ROM exercises* focus on knee flexion movements that involve the lower extremity muscles so that they can help maintain muscle mass, prevent atrophy, and gradually increase muscle strength in post-stroke patients. Passive ROM exercises aim to maintain joint flexibility, improve blood circulation, prevent joint stiffness, and help increase lower extremity muscle strength (Fauziyah et al., 2023; Maljuliani et al., 2023). Providing passive ROM exercises regularly and continuously is expected to improve motor function and reduce patient dependence in daily activities. Therefore, effective interventions are needed to increase lower extremity muscle strength in post-stroke patients. Based on this, researchers are interested in examining the effectiveness of passive *Knee Flexion ROM exercises* on lower extremity muscle strength in post-stroke patients at Sumberglagah Regional Hospital.

METHOD

This entire series of studies was conducted based on quantitative research methods using a pre-experimental design through a one-group pre-test and post-test design approach. This study design aims to determine the effectiveness of Passive *Knee Flexion Range of Motion (ROM) exercises* on increasing lower extremity muscle strength in post-stroke patients by comparing measurement results before and after the intervention. This approach allows researchers to evaluate changes in muscle strength after administering *Knee Flexion ROM exercises* to the same group of respondents without using a control group.

This research was conducted at the Medical Rehabilitation Clinic of Sumberglagah Regional Hospital, Pacet District, Mojokerto Regency. The research was conducted in May 2026, following a preliminary study conducted in February 2026 to identify problems

encountered in post-stroke patients, particularly regarding decreased lower extremity muscle strength. The researchers then conducted a research process that included collecting initial data (pre-test), administering Passive *Knee Flexion ROM exercise interventions* according to Standard Operating Procedures (SOP) for five days, and then conducting a final measurement (post-test) to determine changes in muscle strength after the intervention.

The population in this study was all post-stroke patients undergoing rehabilitation at the Medical Rehabilitation Clinic of Sumberglagah Regional Hospital during the study period. The sampling technique used total sampling, meaning all members of the population who met the inclusion criteria were selected as respondents. Based on the respondent selection results, a sample size of 35 post-stroke patients was obtained.

The research instruments used consisted of Standard Operating Procedures (SOP) for Passive *Knee Flexion Range of Motion (ROM) exercises* as a guideline for implementing the intervention and a Manual Muscle Testing (MMT) observation sheet as a tool for measuring lower extremity muscle strength. Muscle strength measurements were conducted twice, namely before the exercise (pre-test) on the first day and after the exercise (post-test) on the fifth day. The data obtained were then analyzed using the Wilcoxon Signed Rank Test because it aims to compare the measurement results before and after the intervention in the same group. The results of the analysis were used to determine the effectiveness of Passive *Knee Flexion ROM exercises* on increasing lower extremity muscle strength in post-stroke patients.

FINDING AND DISCUSSION

RESEARCH RESULT

Table 1 : Frequency distribution of respondents' muscle strength before ROM *Knee Flexion* exercise in post-stroke patients

No.	Kriteria	Kekuatan otot sebelum latihan ROM <i>Knee Flexion</i> pada pasien post stroke	
		Frekuensi	Presentase(%)
1	Zero	4	11,4
2	Trace	10	28,6
3	Poor	13	37,1
4	Fair	8	22,9
5	Good	0	0
6	Normal	0	0
Total		35	100,0

Source: Special Data, 2026

The results of table 1 show that almost half of the muscle strength after doing ROM *Knee Flexion exercises* was Poor (there was movement but could not fight gravity) as many as 13 respondents (37.1%).

Table 2 : Frequency distribution of respondents' muscle strength after ROM *Knee Flexion* exercise in post-stroke patients

No.	Kriteria	Kekuatan otot sesudah latihan ROM <i>Knee Flexion</i> Pada pasien post stroke	
		Frekuensi	Presentase%
1	Zero	1	2,9
2	Trace	3	8,6
3	Poor	4	11,4
4	Fair	12	34,3
5	Good	14	40,0
6	Normal	1	2,9
Total		35	100,0

Source: Special Data, 2026

The results of table 2 show that almost half of the muscle strength after undergoing ROM *Knee Flexion* Good exercise (can move muscles against light resistance) was 14 respondents (40.0%).

Table 3 : Frequency Distribution of Respondents' Muscle Strength Before and After *Knee Flexion ROM* Exercise in Post-Stroke Patients

No.	Kekuatan otot sebelum latihan ROM <i>Knee Flexion</i> pada pasien <i>post stroke</i>			Kekuatan otot sesudah latihan ROM <i>Knee Flexion</i> pada pasien <i>post stroke</i>		
	Kriteria	Frekuensi	Presen(%)	Kriteria	Frekuensi	Presen(%)
1	Zero	4	11,4	Zero	1	2,9
2	Trace	10	28,6	Trace	3	8,6
3	Poor	13	37,1	Poor	4	11,4
4	Fair	8	22,9	Fair	12	34,3
5	Good	0	0	Good	14	40,0
6	Normal	0	0	Normal	1	2,9
Jumlah		35		35		
<i>P-value: 0.000</i>			<i>α = <0.05</i>	<i>Z = -5.265</i>		

Source: Special Data, 2026

Knee Flexion exercise, initial muscle strength was Zero, there were 4 (11.4%) respondents to 1 (2.9%) respondents, original muscle strength was Trace 10 (28.6%) respondents to 3 (8.6%) respondents, original muscle strength was Poor 13 (37.1%) respondents became 4 (11.4%), original muscle strength was Fair 8 (22.9%) respondents became 12 (34.3%) respondents, Initially Good muscle strength 0 (none) became 14 (40.0%) respondents, and Initially Normal muscle strength 0 (none) became 1 (2.9%) respondents, with 34 respondents experiencing changes in lower extremity muscle strength and 1 respondent experiencing no change in lower extremity muscle strength.

Based on the results of the analysis using the Wilcoxon Signed Rank Test, the p-value was obtained = 0.000 ($p < 0.05$). Thus, it can be statistically concluded with a 95% confidence level that *Knee Flexion Range of Motion (ROM) exercises* have a significant effect on increasing lower extremity muscle strength in post-stroke patients. The Z value of -5.265 indicates a significant difference between muscle strength before (pre-test) and after (post-test) exercise. The negative sign on the Z value only indicates the direction of data change, namely that most muscle strength values after the intervention are higher than before

the intervention. (ROM) *Knee Flexion* has been proven effective in increasing lower extremity muscle strength in post-stroke patients.

DISCUSSION

Muscle strength of respondents before ROM *Knee Flexion* exercise in post-stroke patients.

The results of the research analysis based on table 4.2 show that before being given ROM *Knee Flexion exercises*, most respondents had Poor muscle strength as many as 13 respondents (37.1%). Based on the characteristics of the respondents, it is known that most of the respondents were female, namely 18 respondents (51.4%), aged 45-59 years, namely 17 respondents (48.6%). And most of them had a stroke within 6 months, namely 31 respondents (88.6%). Most of them had their first stroke, namely 25 respondents (71.4%).

The low muscle strength of the lower extremities before receiving ROM *Knee Flexion exercises* indicates that most respondents still experienced impaired motor function due to stroke. In nursing, this condition is the basis for the emergence of physical mobility problems, which are characterized by limited movement, decreased walking ability, impaired balance, and dependence in performing daily activities. If this condition is not immediately addressed through an appropriate rehabilitation program, patients are at risk of complications such as muscle atrophy, joint contractures, decreased range of motion, and a decreased quality of life. Therefore, ROM exercises are an important rehabilitative intervention to maintain joint flexibility, provide neuromuscular stimulation, and prevent further decline in muscle function (Maljuliani et al., 2023; Rahayu & Nuraini, 2025). Based on age characteristics, most respondents were in the 45-59 year age range. These results are in line with the theory that increasing age causes a decrease in muscle mass and strength due to physiological degenerative processes. The decline in muscle strength generally begins to occur from the age of 40 and becomes more pronounced in old age. Researchers from Columbia University Medical Center explained that the aging process causes calcium ion leakage in ryanodine receptors within muscle cells, resulting in suboptimal muscle contraction. In stroke patients, this condition is further exacerbated by impaired blood flow to the brain, which inhibits the transmission of nerve impulses to the brain, thus decreasing the muscle's ability to contract (Andersson et al., 2011). Therefore, the muscle weakness experienced by respondents is not only influenced by the aging process but also a direct impact of nervous system damage caused by stroke.

In terms of gender, the majority of respondents were female. In theory, women have lower muscle mass, number of muscle fibers, and proportion of muscle tissue than men, while having a relatively higher percentage of body fat. This condition causes the ability to generate muscle strength in women to tend to be lower than in men (Mei Leni & Triyono, 2018). According to the researchers' assumption, these characteristics also contribute to the low muscle strength found in most respondents, although muscle weakness in stroke patients is still influenced by the extent and location of brain tissue damage experienced by each individual.

Based on the duration of stroke, most respondents had experienced a stroke for less than 6 months. This result contrasts with the theory that the longer a person has suffered a stroke, the greater the risk of decreased muscle strength due to reduced physical activity, muscle atrophy, and changes in neuromuscular function. The researchers hypothesized that

this difference is likely due to the majority of respondents being in the early stages of rehabilitation, so the muscle weakness experienced is more influenced by neurological damage caused by the stroke than by the duration of the disease. Furthermore, muscle strength is influenced not only by stroke duration but also by the location of the brain lesion, stroke severity, compliance with rehabilitation, general health, and other therapies received during treatment. Based on stroke history, most respondents experienced their first stroke. This finding suggests that decreased muscle strength can occur from the first stroke due to damage to the area of the brain that controls motor function. This damage disrupts nerve impulses to the muscles, resulting in muscle weakness, decreased mobility, atrophy, and even spasticity if not promptly and adequately rehabilitated. The researchers hypothesized that although the majority of respondents had only experienced their first stroke, the neurological damage was sufficient to cause most respondents to be in the Poor muscle strength category before being given *Knee Flexion ROM exercises*. Based on the overall results of the study, researchers concluded that low lower extremity muscle strength before being given ROM *Knee Flexion exercises* was influenced by various interacting factors, namely age, gender, neurological conditions due to stroke, duration of stroke, and history of stroke attacks. Although most respondents were still in the phase of less than six months and experienced their first stroke, the resulting nervous system damage had caused a decrease in muscle contraction ability so that most respondents were in the Poor category before being given intervention. This condition indicates that post-stroke patients require rehabilitation as early as possible to maintain motor function and prevent more severe decline in ability.

Muscle strength of respondents after ROM *Knee Flexion exercise* in post-stroke patients

The results of the research analysis based on table 4.3 show that after being given ROM *Knee Flexion training*, 1 (2.9%) respondent experienced Zero muscle strength (no muscle movement at all), 3 (8.6%) respondents experienced Trace muscle strength (there was contraction during palpation but no visible movement), 4 (11.4%) respondents had Poor muscle strength (can move muscles but not yet able to fight gravity), 12 (34.3%) respondents had Fair muscle strength (can move muscles against gravity), 14 respondents (40.0%) had Good muscle strength (can move and can fight light resistance), 1 respondent (2.9%) had Normal muscle strength (can move and fight resistance). These results indicate that most respondents are in the Good category. The Good category indicates that respondents are able to move their lower extremities fully and are able to fight light resistance. These findings indicate an increase in motor skills after being given ROM *Knee Flexion training* compared to before the intervention.

According to (Mufidah & Rachmawati1, 2024), ROM exercises aim to maintain motor function, prevent contractures, prevent neurovascular decline, improve blood circulation, and maintain and increase muscle strength. ROM is a rehabilitative intervention that can be performed actively or passively. In post-stroke patients experiencing muscle weakness, passive ROM plays a role in maintaining joint mobility, increasing blood flow to tissues, and providing stimulation to the neuromuscular system, thus helping the process of restoring motor function. In addition, regular ROM exercises can prevent complications due to immobilization, such as muscle atrophy, joint stiffness, and limited range of motion, thus supporting the improvement of the patient's functional abilities.(Wati et al., 2023).

Based on the research results, most respondents were in the Good category after being given ROM *Knee Flexion exercises*. These results indicate that ROM exercises can stimulate muscles and joints, thereby increasing muscle contraction ability. Repeated knee flexion movements help maintain the elasticity of muscles and surrounding tissues, improve blood circulation, and improve coordination between the nervous system and muscles. This condition allows patients to perform lower extremity movements better and be able to resist light resistance. According to the researchers' assumption, this increase in ability occurs because regular ROM exercises can stimulate the neuromuscular adaptation process, resulting in more optimal lower extremity motor function. In addition to the Good category, there were still respondents who were in the Fair, Poor, Trace, and even Zero categories after the intervention. These findings indicate that the response to ROM exercises varies across patients. According to the researchers' assumption, these differences are likely influenced by several factors, such as age, stroke severity, location of brain damage, length of stroke, adherence to exercises, general health conditions, and other rehabilitation therapies received during treatment. These factors can affect the nervous system's ability to transmit impulses to muscles, resulting in different rates of muscle strength recovery in each individual. Therefore, although ROM exercises provide benefits, the results obtained by each patient are not always the same.

In this study, there was also 1 respondent (2.9%) who did not experience an increase in muscle strength after being given ROM *Knee Flexion exercises*. According to the researchers' assumption, this condition was likely caused by a more severe level of neurological damage, slower nerve regeneration ability, or the presence of other factors that were not studied, such as nutritional status, comorbidities, patient motivation, or compliance in following the rehabilitation program. These results indicate that the effectiveness of ROM exercises can be influenced by the characteristics of each patient so that not all patients respond equally to the intervention.

Based on the research results, 17 respondents (48.6%) experienced a one-level increase in muscle strength after being given ROM *Knee Flexion exercises*. This increase indicates that ROM exercises have been able to improve muscle contraction ability so that respondents experienced motor function development compared to before the intervention. According to Mufidah & Rachmawati (2024), ROM exercises can help maintain joint flexibility, improve blood circulation, and maintain and increase muscle strength in post-stroke patients. According to the researchers' assumptions, a one-level increase indicates that the process of motor function recovery takes place gradually. This is because nerve tissue recovery after a stroke takes time so that muscle strength increases cannot occur instantly even though patients have undergone ROM exercises.

Furthermore, some respondents experienced a two-level increase in muscle strength after receiving *knee flexion ROM exercises*. This indicates that some respondents responded better to rehabilitation than others. Researchers believe this improvement was likely influenced by better neurological conditions, relatively younger age, high patient motivation, adherence to the exercises, and family support during the rehabilitation process. These factors can accelerate the neuromuscular adaptation process, resulting in more optimal muscle strength gains.

Based on the overall research results, researchers concluded that *knee flexion ROM exercises* provide benefits in increasing lower extremity muscle strength in post-stroke

patients. The increase in muscle strength, which was predominantly in the Good category, indicates that ROM exercises can improve muscle contraction ability and lower extremity motor function. However, some respondents still experienced limited or no improvement. This indicates that the success of ROM exercises is influenced not only by the intervention provided, but also by patient characteristics, neurological conditions, stroke severity, rehabilitation compliance, and other individual factors. Therefore, ROM exercises need to be performed regularly, continuously, and tailored to each patient's condition to optimize rehabilitation results.

Analysis of the influence of muscle strength before and after Range of Motion (ROM) Knee Flexion exercise in post-stroke patients

Based on table 4.4 muscle strength before being given passive ROM exercises, most respondents were in the low muscle strength category, namely the Poor category with 13 respondents (37.1%). After being given passive ROM exercises, there was a decrease in the number of respondents in the low muscle strength category, namely the Zero category to 1 respondent (2.9%), the Trace category to 3 respondents (8.6%) and the Poor category to 4 respondents (11.4%). On the other hand, the number of respondents in the Fair category increased to 12 respondents (34.3%), the Good category increased to 14 respondents (40.0%), and the Normal category to 1 respondent (2.9%). The biggest change occurred in respondents who experienced an increase from the Trace category to Fair with 8 respondents. This finding indicates an increase in lower extremity muscle strength after being given ROM *Knee Flexion exercises*.

According to (Purba et al., 2022), ROM exercises can increase muscle strength by stimulating neuromuscular and muscular activity that stimulates muscle contraction and helps maintain joint mobility. This opinion is supported by (Wahyuni et al., 2022) who stated that ROM exercises performed regularly can increase muscle strength, improve nerve function, and support the rehabilitation process in post-stroke patients. In addition, (Susanti et al., 2019) explained that passive ROM exercises *Knee Flexion* is useful in preventing joint stiffness and contractures, maintaining knee flexibility, preventing muscle atrophy, improving blood circulation, and providing sensorimotor stimulation that supports the recovery of lower extremity motor function. However, (Pinontoan et al., 2015) stated that advanced age remains a factor that can inhibit increased muscle strength due to the degenerative processes that occur during aging.

Based on the research results and theory, ROM *Knee Flexion exercises* have been proven to have an effect on increasing lower extremity muscle strength in the majority of respondents. The most dominant increase occurred in the change from the Trace to Fair category, which indicates that respondents have experienced an increase in muscle contraction ability to be able to perform movements against gravity. According to the researcher's assumption, this increase occurs because ROM exercises performed regularly are able to provide repeated stimulation to the neuromuscular system, improve blood circulation to muscle tissue, and maintain joint flexibility so that muscle contraction ability gradually increases.

The results of this study also showed that 34 respondents experienced increased muscle strength, while 1 respondent experienced no change after being given ROM *Knee Flexion exercises*. This finding is consistent with research by Li et al. (2019), Singh and

Sharma (2021), and Park and Kim (2020), which stated that regular ROM exercises can increase muscle strength, improve motor function, reduce complications due to immobilization, and support the recovery of functional abilities of post-stroke patients. These similar results further strengthen the evidence that ROM exercises are an effective rehabilitative intervention in increasing lower extremity muscle strength in post-stroke patients. The increase in muscle strength observed in most respondents is thought to be related to the physiological mechanisms of ROM exercises. Repeated *Knee Flexion movements* stimulate the neuromuscular system, thereby increasing the transmission of nerve impulses to the muscles. In addition, ROM exercises help improve blood flow and oxygen supply to muscle tissue, maintain muscle and joint elasticity, and prevent atrophy and contractures due to immobilization. According to the researchers' assumption, these mechanisms play a role in increasing muscle contraction ability, resulting in most respondents experiencing increased muscle strength after the intervention. However, there was still 1 respondent who did not experience an increase in muscle strength after being given ROM *Knee Flexion exercises*. According to the researcher's assumption, this condition is likely influenced by advanced age, a more severe level of neurological damage, the presence of comorbidities, motivation and compliance during the exercise, and the duration and frequency of intervention that were not enough to produce changes in muscle strength. In addition, ROM exercises are basically more focused on maintaining joint mobility and preventing complications due to immobilization, so that increasing muscle strength in some patients requires a longer rehabilitation period and continuous exercise.

knee flexion range of motion (ROM) exercises significantly increased lower extremity muscle strength in post-stroke patients. The improvements seen in most respondents indicate that ROM exercises can improve muscle contraction ability and lower extremity motor function. However, the success of ROM exercises is influenced not only by the intervention provided but also by age, stroke severity, neurological condition, rehabilitation compliance, and individual patient characteristics. Therefore, ROM exercises need to be performed regularly, continuously, and tailored to the patient's condition to achieve rehabilitation results. optimally .

Then, adequate infrastructure also supports the success of online learning implementation. Based on the results, it was found that the students agreed to the implementation of online learning due to its accessibility which is easy to do anywhere and supported by adequate equipment (laptop, gadget, internet connection, etc.). These findings are in line with the findings of Elyas (2018) revealed that online learning can be accessed from anywhere that has access to the internet. The last positive perception comes from learning activity. Based on the questionnaire results, the majority of students have been able to organize themselves to be more independent and disciplined. This is proven by them doing assignments independently and are on time during online learning. These findings similar to Kusuma (2020) revealed that the implementation of online learning had an impact on the independence of student learning in Geometry courses during distance learning. However, the results showed that online learning also made some students give negative perceptions such as some students agreeing that the lecturer gave a lot of assignments. This finding in line with findings from Maqbulin (2021) revealed that one of the students' problems in the process of online learning during the pandemic was many tasks that students had to complete.

A study from Cahyawati and Gunarto (2020) also found that students argued that their workload was more than during face-to-face learning.

Next, the management of learning by lectures. The results showed that students agreed that the delivery of material was done directly during the meeting rather than just sending some links. This is shown that implementation of online learning will run better if there is direct interaction between lecture and students. The similar finding from Sun, et.al. (2022) the findings demonstrated that interaction between educators and students not only has a beneficial effect on learning outcomes, but also has an impact on learning outcomes through the mediating effects of psychological environment and learning engagement. Then, the results also showed that some students also experienced slight problems with internet network connectivity. The similar findings from Adnan (2020) revealed that internet connectivity, finance, and the lack of interaction with teachers were some problems faced by students' in online learning.

CONCLUSION

Based on the results of the study, there were 35 respondents in May 2026, it was found that 34 respondents experienced an increase in lower extremity strength and 1 respondent did not experience a change in lower extremity muscle strength after being given Range Of Motion (ROM) *Knee Flexion exercises*. The increase in muscle strength is thought to be influenced by several factors, such as gender, age, length of stroke, and history of stroke. In addition, respondents who did not experience an increase in muscle strength are thought to be influenced by the initial condition of very weak muscle strength so that the recovery process of motor function is more limited. Based on the results of the Wilcoxon Signed Rank Test statistical test, a p-value of 0.000 was obtained where the significance result was less than 0.05, so it can be concluded that there is a difference in lower extremity muscle strength before (pre-test) and after (post-test) given Range Of Motion (ROM) *Knee Flexion exercises*. Thus, Range Of Motion (ROM) *Knee Flexion exercises* are proven to be effective in increasing lower extremity muscle strength in post-stroke patients.

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