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Journal of Roi Et Rajabhat University: Science and Technology 6(2), 96-105

Stretching and Strengthening Exercises Improve Functional Activities and Independence in Individuals with Physical Disabilities in Pekalongan Regency

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Received: 7 July, 2025; Revised: 13 August, 2025; Accepted: 22 August, 2025

Abstract

This study aimed to evaluate the effectiveness of a structured physiotherapy program, specifically designed to include a series of PNF-based active stretching exercises and progressive strengthening exercises, in improving functional activity and walking independence in people with physical disabilities. The increasing number of people with disabilities in Pekalongan Regency indicates the urgency of effective health services to improve their quality of life. This study used a quasi-experimental one-group pretest-posttest design with a 20-day intervention. The target population consisted of individuals with disabilities aged 21–50 years, selected because they were in their productive years and had optimal exercise adaptation capacity, with FIM scores ≥ 65 and GMFCS ≤ 4, to ensure participants had a basic level of independence that enabled active participation. A sample of 50 people was selected purposively. Data analysis used a paired t-test after the Kolmogorov-Smirnov normality test. Results showed significant improvements in FIM ($p < 0.001$; SD ± 2.949) and GMFCS ($p < 0.001$; SD ± 1.864) scores following the intervention. This program has the potential to be widely implemented in community and clinical rehabilitation services to improve the independence and productivity of people with physical disabilities.

Keywords: physiotherapy; physical disability; functional activities

Introduction

Globally, people with physical disabilities face multidimensional challenges, ranging from limited mobility and social participation to access to healthcare. WHO data shows that approximately 16% of the world's population lives with some form of disability, and in developing countries, this number tends to increase due to injuries, chronic diseases, and a lack of adequate rehabilitation services. In Indonesia, attention to people with disabilities has been realized through various policies, including Law Number 8 of 2016 concerning Persons with Disabilities. In Pekalongan Regency, the number of people with disabilities increased from 800 in 2019 to 6,000 in 2021. The local government has issued Regent Regulation Number 2 of 2020 concerning the protection and fulfillment of the rights of people with disabilities, as well as Regent Regulation Number 85 of 2022, which guarantees physiotherapy services at community health centers. However, people with physical disabilities in this region still face problems such as chronic pain, limited mobility, decreased muscle strength, impaired coordination, and impaired balance. A structured physiotherapy approach, including stretching and strengthening exercises, can overcome these barriers. Stretching improves flexibility and joint range of motion,

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while strengthening exercises provide stability and prevent muscle atrophy. The regulation states that physiotherapy services are provided at community health centers (Puskesmas) to facilitate access to physiotherapy services for people with disabilities. This includes promoting independence through various interventions, including exercise and equipment approaches (Dinsos Kabupaten Pekalongan, 2022). People with disabilities in Pekalongan Regency still need to be empowered to increase their potential and productivity to ensure their well-being. Financial well-being can be achieved when health and fitness are good (Krisnawati & Anggiat, 2021). Meanwhile, those with physical disabilities experience impaired movement and function, which can compromise physical fitness.

The problems associated with disabilities are complex, but the most common physical impairments include pain, limited mobility, decreased muscle strength, impaired coordination, impaired balance, and so on (Çubukçu & Karaoğlu, 2020). According to the International Classification of Function (ICF), these problems are referred to as body function and body structure. The impact of these problems is decreased functional ability (Begum et al., 2019). Physiotherapy approaches, including stretching and strengthening exercises, can reduce problems associated with disabilities. Stretching can increase joint range of motion caused by muscle tension. Increasing joint range of motion will impact functional ability, thereby improving the quality of life for people with disabilities. Continuous passive stretching exercises can allow muscles and tendons to adapt to the increased range of motion. Combining stretching exercises with orthopedic devices such as casts or standing desks for people with cerebral palsy can improve muscle and tendon plasticity, thereby reducing joint limitations (Begum et al., 2019). Stretching exercises for people with disabilities experiencing limited mobility due to prolonged immobilization can reduce the risk of deformity and atrophy. Effective stretching exercises are balanced with strengthening exercises to stabilize joints, thus increasing the effectiveness of the stretching (Kalkman et al., 2020).

Strengthening exercises for people with disabilities can increase strength and stabilize joints experiencing resistance (Kalkman et al., 2019, 2020). People with disabilities experience impaired coordination due to muscle imbalance, which occurs when one muscle overcontracts and the opposite muscle is pulled, resulting in weakness. Strengthening exercises are given in the opposite direction to the shortened muscle (Valadão et al., 2021). This method is based on the PNF pattern, so that the tense muscle is actively stretched, and the weak muscle is contracted to strengthen. Strengthening exercises for people with disabilities, especially those with cerebral palsy (CP), are very effective in increasing muscle strength. This combination of exercises can improve muscle structure in people with disabilities, thereby increasing functional activity and independence.

This study aims to evaluate the effectiveness of a structured physiotherapy program combining PNF-based active stretching and progressive strengthening exercises on improving functional activity and walking independence in people with physical disabilities in Pekalongan Regency. The findings of this study are expected to provide a scientific basis for the implementation of community-based rehabilitation programs, particularly in areas with a high prevalence of disability, and to strengthen cross-sector collaboration in empowering people with disabilities to become more independent and productive.

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Research Method

This study used a quasi-experimental design with a one-group pretest-posttest approach, comparing outcomes before and after a structured physiotherapy intervention. The intervention consisted of PNF-based active stretching exercises and progressive strengthening exercises, performed daily for 20 days, with a duration of 10–20 minutes per session.

The Gross Motor Function Classification System (GMFCS) research instrument was used to measure walking ability. The GMFCS was developed by Palisano et al. (1997) and has demonstrated high reliability (interrater reliability ICC > 0.90) in populations with physical disabilities (Choi, 2024). The GMFCS is interpreted as level 1: an individual can walk independently without assistance; level 2: requiring light assistance such as a handrail when climbing stairs; level 3: requiring assistance such as a walker or wheelchair but not requiring assistance from another person; level 4: requiring minimal assistance with a device or other person; and level 5: requiring full assistance with either a device or a person for mobility. The Functional Independence Measure (FIM) was developed by the Uniform Data System for Medical Rehabilitation (Gkouma et al., 2022) with test-retest reliability reported at an ICC of 0.95. The questionnaire consisted of 18 questions, each with a Likert scale ranging from 1 to 7. The 18 items included: 6 questions on self-care skills, 2 on sphincter control skills, 3 on transfer skills, 2 on ambulation skills, 2 on communication skills, and 3 on socialization skills. The lowest score on the Likert scale was 1, indicating full assistance required, and 7, indicating complete independence in functional activities. The lowest total score was 18, indicating full assistance was required, and the maximum score was 126.

Field Application Method

The GMFCS and FIM instruments were administered through structured interviews and direct observation. Measurements were conducted by two certified physiotherapists who had received specific training in the instrument's scoring procedures to ensure inter-rater consistency. Before data collection, an interrater agreement test was conducted on 10% of the initial sample, with a concordance rate of >90%.

The population was recruited from people with disabilities in Pekalongan Regency, with the following inclusion criteria: age 21–50 years, FIM score ≥ 65, and GMFCS score ≤ 4. This selection of participants of productive age was intended to ensure that participants had optimal physical capacity to participate in the training and were relevant to the local employment empowerment program (Tan, 2021). Exclusion criteria included requiring full assistance or undergoing routine medical/physiotherapy interventions elsewhere.

Data collection and analysis

Data collection before the intervention included gait ability and functional activity measurements; these data served as pre-data. After the 20-day intervention, GMFCS and FIM measurement served as post-data. The intervention consisted of stretching and strengthening exercises for the upper and lower limbs. Each movement was performed 10–20 times per set, then increased to two sets in the final 10 days, with repetitions increased to 20–30 times. These exercises were performed once daily, according to the prescribed dosage. The data tested were pre- and post-intervention data. The pre-intervention data were collected before the intervention, and the post-intervention data were collected after the intervention, which consisted of PNF stretching and strengthening methods for 20 days.

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Data analysis was performed using the Kolmogorov-Smirnov normality test and a paired sample t-test to examine differences in FIM and GMFCS scores before and after the intervention.

Results and Discussion

This study was conducted with a sample of 50 people with disabilities, and the sample criteria were determined by inclusion and exclusion to obtain an appropriate sample. This study has several criteria, including age, gender, and type of disability. Details of respondents or samples were presented in Table 1. The results of the age in disabilities in the physiotherapy assistance program from 50 people with disabilities with an age range of 21 - 50 show that the most age group was 31 - 40 years with a total of 28 disabilities, followed by 21 - 30 years with a total of 11 disabilities. The results of the age in disabilities were the same as the screening results, which the requirements for physiotherapy assistance and batik assistance at a productive age and not underage so that it did not violate the rules on working with minors. The results of gender in disabilities in the physiotherapy assistance program of 50 disabilities were 26 with male gender and 24 with female gender. Therefore, the participants of physiotherapy assistance in disability were mainly male gender.

Table 1 Frequency of Respondents

Characteristics of Respondents	Frequency	100%
Age (year)		
21 - 30	11	0.22
31 - 40	28	0.56
41 - 50	11	0.22
Gender		
Male	26	0.52
Female	24	0.48
Type of Disability		
Amputation	10	0.20
Atrophy	2	0.40
Cerebral Palsy	6	0.12
Congenital Talipes Equinovarus (CTEV)	2	0.40
Dwarfism	9	0.18
Erb palsy	1	0.20
Post Fracture	4	0.80
Genu valgus	1	0.20
Hemiparesis	2	0.40
Multiple sclerosis	2	0.40
Polio	8	0.16
Scoliosis	3	0.60

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The results of physiotherapy assistance to 50 people with disabilities in this program were 16 diagnoses or types of disabilities, and the types of disabilities varied greatly. The table shows that the most frequent participants were amputations, with a total of 10 disabilities, whether hand or foot amputations. The next was the diagnoses of dwarfism, the body's limbs do not grow normally, and polio, which had a total of 9 disabilities. Physical disability problems by the diagnosis in physiotherapy assistance were the same as the initial screening target. The youngest respondent was 21 years old and the oldest was 50 years old, with a mean of 35.82 ± 7.348. The minimum value of the results of measuring walking independence in disability whether before or after intervention was 1, which means it was still low, while the maximum was 3 whether before or after intervention. However, the mean and standard deviation pre-intervention was 2.32 ± 0.819, while the mean and standard deviation of GMFCS post-intervention was 1.92 ± 0.829. It shows that the functional ability of people with disability pre-intervention had a minimum value of 75, a maximum value of 120, and a mean of 100.88 ± 15.901. Meanwhile, the functional ability intervention had a minimum value of 80, a maximum value of 126, and a mean and standard deviation of 107.12 ± 16.945 (Table 2)

Table 2 Description of Respondents

Variable	N	Min	Max	Mean	SD
Age	50	21	50	35.82	±7.348
GMFCS pre	50	1	3	2.32	±0.819
GMFCS post	50	1	3	1.92	±0.829
FIM pre	50	75	120	100.88	±15.901
FIM post	50	80	126	107.12	±16.945

Normality Test of Data

This study involved 50 respondents, and it was necessary to test the normality of the data to determine the difference test so that the research showed valid results. The data normality test in this study used a one-sample Kolmogorov-Smirnov test on 50 respondents. The variables tested were GMFCS and FIM pre and post intervention. The GMFCS data pre and post intervention had a value of $p>0.05$ (p value = 0.844), which means the data was normally distributed. The data was also transformed and revisualized so that the test was made as one sample. Table 3 shows that the results of the data normality test pre and post intervention on functional ability with FIM showed a value of $p>0,05$ (p value = 0.605), which means the data was normally distributed (Table 3). Based on the previous normality test data, the GMFCS measurement data was normally distributed. Therefore, the difference test in this study used a parametric paired sample t-test. The test results can be seen in the following table.

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Table 3 Normality Test of Data

Characteristic	N	*P*
GMFCS pre	50	0.844
GMFCS post	50	
FIM pre	50	0.605
FIM post	50	

Table 4 Difference Test Pre and Post Intervention

Characteristic	SD	*P*
GMFCS pre - GMFCS post	±2.949	0.00
FIM pre - FIM post	±1.864	0.00

Based on Table 4, the GMFCS pre and post intervention had a value of $p<0.05$, which means there was a difference in walking independence ability before and after the intervention. The standard deviation between GMFC pre and post intervention is SD ±2.949 which showed increased walking independence in disability.

Based on Table 4.4, the functional ability of people with disability pre and post intervention was different in that the *p* value of FIM pre and post was<0.00 with a standard deviation of SD ±1.864. These results indicated an increase in functional ability after intervention for disability.

The results of this study support the hypothesis that physiotherapy can improve functional activities in individuals with physical disabilities. Physiotherapists would be able to treat musculoskeletal, neurological, and respiratory problems that may be specifically related to a person's condition or something completely unrelated. Muscle strengthening and flexibility exercises help to improve physical ability and increase independence in walking so that the quality of life will be better. Those who reported doing general muscle strengthening activities (n ¼ 685) had a lower risk of developing functional limitations [OR ¼ 0.79 (0.63-1.00)] (Kalkman et al., 2019; Pfeifer et al., 2022; Valadão et al., 2021). In addition, specific flexibility activities such as stretching (n ¼ 491) and calisthenics (n ¼ 122) were associated with an opportunity decrease of incident functional limitations by 24% and 38% (Pfeifer et al., 2022).

Increasing functional activity in disabilities with a physiotherapy approach in the form of independent exercise is the impact of understanding from the disabled about the importance of exercise to maintain or reduce the risk of more severe disability (Pratama & Prayudipta, 2022). Exercise in the form of active stretching that is done can be more effective because it can measure pain tolerance so that it does not cause overstretching in the muscles that cause injury. Muscle stretching can increase the range of motion of the joints, whereas stretching can increase muscle elasticity so that muscles that experience tension will decrease (Hermawan et al., 2022; Llamas-Ramos et al., 2022). Muscle tension in disabilities, especially spastic cerebral palsy conditions, can increase muscle tone due to spasticity, in the long term it will cause joint limitations because muscles limit movement (Çubukçu & Karaoğlu, 2020). Stretching exercises given to the disabled in this study were in the form of self-stretching with guidelines that had been made by researchers to make it easier for the disabled (Llamas-Ramos et al., 2022; Zafar et al., 2024). A study of Stretching exercises with the

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proprioceptive neuromuscular facilitation (PNF) method can improve the quality of life in patients with osteoarthritis conditions who experience pain so that they experience decreased activity (Zafar et al., 2024). In this study, people with disabilities did active stretching every day for 20 days on the upper and lower limbs for 10-15 minutes, resulting in increased muscle strength. Stretching done for 15-30 minutes in each Movement with 10 repetitions can reduce disability conditions in patients with complaints of pain and limited movement due to increased tone. Stretching exercises performed bilaterally in disabilities such as post-stroke will improve the quality of movement and muscle strength (Handini et al., 2022).

This is due to the contralateral stimulation of healthy limbs to the affected limbs. The principle of stretching with PNF stretches contracts that utilize irradiation, where if the limbs are stretched with quite heavy resistance, the other limbs will follow (Salphale et al., 2021). The physiological mechanism of stretching exercises is the elongation of myofibrils causing increased flexibility, but if it is excessive, the muscle spindles that send signals to the nerves to control the muscles are not more interested in preventing injury (Wongwilairat et al., 2019). However, stretching that is done slowly and repeatedly will reduce muscle resistance to stretching, thereby reducing tension. Muscles are active stabilizers and active movers, therefore if the muscles are more flexible then the range of joint movement will follow and not become more limited (Kalkman et al., 2019)

Decreased activity in disabilities is a problem of decreased muscle strength caused by hypomobility due to congenital or pain, besides that it can also occur due to deformity. This problem can arise due to a lack of understanding of disabilities and families and communities. Community-based physiotherapy assistance and education are very effective in improving the quality of life of disabilities, this is evidenced by the family's understanding of the conditions and needs of disabilities (Pratama & Prayudipta, 2022). Independent exercise programs such as strengthening and stretching can increase muscle strength in disabilities, but this program has the weakness of a lack of support from the government and human resources that can help it. Strengthening exercises with resistance according to the tolerance of disability ability can prevent muscle atrophy and reduce the risk of disability (Simón-Siles et al., 2022). Resistance exercises by contracting muscles isotonic can increase muscle mass (O'Driscoll et al., 2011; Simón-Siles et al., 2022). Strengthening exercises on the abdominal muscles can also improve balance and coordination of movement in the lower extremities.

Physical disabilities such as cerebral palsy and stroke often experience mobility disorders such as walking due to balanced disorders. A study explains that core stability exercises are very effective in improving postural stability so that balance and coordination of movement are good (Akhtar et al., 2017; Djawas, 2022). This can happen because the core muscle is the link between the upper and lower extremities and can control both. Good core muscle conditions mean that improvements in movement coordination are more significant and affect muscle strength so that walking or mobilization abilities increase. A well-structured physiotherapy program can be applied as part of rehabilitation for individuals with physical disabilities. Emphasis on specific exercises and pain management techniques is key to the effectiveness of the intervention. Limitations of this study include the sample size that varies in type of disability and the determination of the dose of intervention for each disability according to tolerance so that there are differences in the results of each development. Further research with more specific samples and intervention doses more equated to each sample according to conditions.

A well-structured physiotherapy program can be implemented as part of rehabilitation for individuals with physical disabilities. Emphasis on specific exercises and pain management techniques is key to the intervention's effectiveness. The study's limitations include the limited sample size and the short duration of the intervention. Further studies with larger samples and more extended intervention periods are needed for more generalized results.

Conclusion

An integrated physiotherapy approach significantly increases functional activities and improves the quality of life in individuals with physical disabilities. A physiotherapy approach that includes stretching and strengthening exercises is effective in enhancing physical activity in individuals with physical disabilities over 20 days, with a duration of 10–20 minutes per day. This approach improves both basic independence and mobility, as measured by GMFCS and FIM. In the future, further research should focus on more specific disability samples. Additionally, stretching exercises can be combined with other supportive devices, such as splints or orthotics. To better measure the effects of stretching and strengthening, electromyography should be used. Future studies may explore similar research topics.

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