

Physical Activity in Neurological Disorders: A Narrative Review

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ABSTRACT

Physical activity levels of people with chronic neurological disorders are lower than those of healthy people. Problems in neurological disorders, including gait abnormalities, muscle weakness/loss of strength, spasticity, tremor, fatigue, balance disorder, and incontinence, results in lower physical activity level. After determining the situations that are contraindicated for physical activity, the patients should be evaluated by physiotherapists, and possible risks that may occur should be determined. Many studies have demonstrated that physical activity significantly reduces mortality and morbidity, increases community participation, and improves health-related quality of life. These benefits show that increased physical activity and exercise should be part of the standard management of neurological disorders. In these patients, physical activity programs should be structured individually by providing appropriate environmental conditions and safety, following the assessment of the functional status and severity of the disease. The duration, intensity, and type of planned physical activity should be adjusted individually; Appropriate rest intervals should be given during the activity, and termination criteria should be determined according to individual tolerance. This literature review aims to provide an up-to-date overview of physical activity recommendations for individuals with chronic neurological disorders.

Keywords: Exercise, Neurologic disorders, Physical activity

INTRODUCTION

People with neurological disorders (stroke, multiple sclerosis (MS), Parkinson's disease, spinal cord injury (SCI), Alzheimer's disease, etc.) have no obstacles to mechanically performing fundamental body movements such as walking, speaking, and grasping. However, they have difficulty performing these movements due to the damage of the disease to the nervous system.¹ In addition, neurological disorders such as gait abnormalities and muscle weakness/loss of strength, spasticity, tremor, fatigue, coordination/balance disorder, and incontinence in individuals with chronic neurological disorders also seriously affect physical activity (PA).^{2,3,4} Decreased PA in people with various neurological disorders may cause a loss of independence during the disease. Also, this situation initiates a cycle that will accelerate the worsening and progression of disability independently of progressive disease processes, resulting in a deterioration of health-related quality of life.³

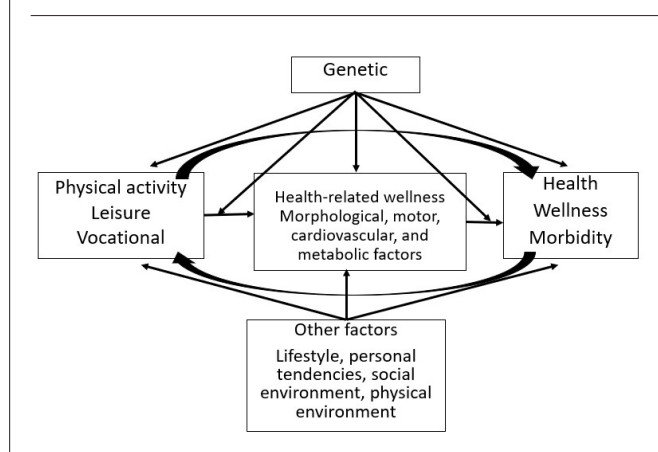
Numerous types of research have indicated the significant benefits of exercise and PA in reducing mortality and morbidity, increasing social participation, and improving health-related quality of life, emphasizing that increasing exercise and PA should be a part of the standard management of neurological disorders.^{1,3,5} However, people with neurological disorders may not be able to participate sufficiently in leisure physical activities and behave more inactively during work and home activities. The most important reasons for avoiding PA in people with neurological problems are shown as health concerns or limitations, symptom severity, pre-existing comorbid conditions, hospitalizations, learning or cognitive problems, societal and environmental factors, insufficient time, risk of injury, lack of self-efficacy, insufficient energy and motivation, and high prevalence of fatigue.^{6,7} There is an important relationship between PA and physical fitness, which affects health outcomes.⁸ A summary of this relationship is presented in Figure 1.

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Figure 1. The relationship between physical health and physical fitness and effective factors



The Importance of Physical Activity in Neurological Disorders

Regular PA, which has an important role in preventing the progression of neurological disorders, has been shown to have positive effects on metabolic disorders which are risk factors for neural system involvement. Regular PA increases the resistance of cells, tissues, and organs to oxidative stress and regulates energy metabolism. It also provides vascularization and neurotrophin synthesis. All of the listed effects are important inducers of muscle growth.⁹ It is known that the neurotrophin brain-derived neurotrophic factor (BDNF) is responsible for regulating the beneficial effects of PA on cognitive functions.¹⁰ It has been demonstrated that moderate and vigorous PA significantly increases BDNF levels. BDNF exists in two forms in the hippocampus re-

Main Points:

- Measuring physical activity (PA), and especially mobility, lets clinicians figure out a patient's functional capability and determine treatment or prognosis. Therefore, PA evaluation is one of the important sub-parameters in planning the rehabilitation program.
- Before starting any PA program, patients with neurological disorders should be evaluated by a specialist physiotherapist and risk screening should be performed.
- Regular PA can help improve cognitive function by stimulating the brain, it improves cognitive capacity with the vessel and neuron formation in certain regions of the brain. Thus the risk of developing neurological disorders such as Parkinson's and Alzheimer's could be decreased with regular PA.
- Regular PA and exercise (aerobic and strength training) have been shown to be beneficial at all stages of recovery and help the management of risk factors in neurological disorders.
- For people with neurological disorders, 150 minutes of moderate-intensity exercise for 10 minutes or longer is recommended as aerobic exercise. Progressive muscle-strengthening activities that involve major muscle groups of the body are to be 2 or more days per week.

gion and has a very important role in neuroplasticity, neurogenesis, and neuron preservation. It has a very important place in the recovery of motor movements after neurodegenerative diseases.

¹¹ Significant evidence from neuroimaging studies in humans indicates that PA promotes structural and functional adaptations in motor and cognitive pathways by improving neuroplasticity (the brain's capacity to change and adapt), both in old age and following brain lesions.¹²

Recent studies in the literature have discovered a strong link between PA and preventing or delaying neurodegenerative symptoms. These studies have demonstrated the role of PA in preventing or delaying the deterioration of motor abilities and mental capacity in patients suffering from many neuro-diseases such as MS and Alzheimer's.¹³ There are shown that PA that offers brain protective effects can be applied to provide endogenous neuroprotection in patients with stroke and act as prototypical preconditioning stimuli that are safe treatment alternatives in other studies.^{14,15} Treadmill training, which is among the types of PA, has become a special focus in trying to understand the effects of PA on neurological disorders in the literature. There is evidence to recommend that prolonged treadmill training for a total of 4 or more weeks, usually involving 3 to 5 sessions per week (30–40 min), leads to motor development and regulation of neurotrophic factor expressions associated with a rise in cell number and the process of generating functional neurons (neurogenesis). Aerobic exercise causes suppression of programmed cell death, a rise in anti-inflammatory cytokine levels, and increases vascularity.^{16–18}

Physical Activity Evaluation in Neurological Disorders

Measuring PA, and especially mobility, lets clinicians figure out a patient's functional capability and determine treatment or prognosis. In the literature, questionnaires, scales, activity diaries, and wearable monitors are used in the evaluation of PA in neurological patients.

3.1. Questionnaire and Scales for Assessment of Physical Activity:

Questionnaires and scales are frequently used in PA assessments in people with neurological disorders. Among these questionnaires, the most commonly used are the Physical Activity and Disability Questionnaire-Revised and the Godin Leisure-Time Exercise Questionnaire.^{19,20}

The Physical Activity and Disability Questionnaire-Revised (PADS-R): It is a questionnaire that evaluates PA conceptually and psychometrically in people with neurological disorders.¹⁹

Godin Leisure-Time Exercise Questionnaire: The questionnaire developed by Godin is aimed at investigating the general activity habits of the subjects rather than questioning them for a certain period. These PA habits try to be defined with a few short questions. The questions are aimed at determining the weekly frequency of activities that get the heart rate up (vigorous exercises), non-strenuous (moderate-intensity exercises), and activities that require the least effort (light exercises). The questions in the other part are about the frequency of activities that are long enough to result in sweating.²⁰

Table 1. Physical activity/Exercise type, frequency, duration, and intensity for patients with neurological disorders

Physical Activity/Exercise Type	Frequency	Duration	Intensity
Aerobic Exercises: - Major muscle activities (e.g. walking, cycling ergometry, treadmill, arm ergometry), functional activities	3-4 days/week	20-60 min. / session (or multiple 10-minute sessions); 5-10 minute warm-up and cool-down activities	40-70% of VO2 reserve or heart rate reserve; 55-80% of maximum Heart Rate
Muscle Strength/Endurance Exercises: - Resistance training of upper-lower extremities and trunk using free weights, elastic bands, spring coils - Circuit training - Functional mobility	2-3 days/week	1-3 sets of 8-10 exercises involving major muscle groups; 10-15 reps.	50-80% of maximum 1 repetition; Resistance is gradually increased over time as endurance allows
Flexibility Exercises: - Stretching exercises (trunk, upper and lower extremities)	2-3 days/week	Static stretches: hold for 10-30 seconds; Before or after aerobic or strength training	Within the normal range of motion
Neuromuscular Exercises: - Balance and coordination activities, tai chi, yoga - Recreational activities - Active play video games and interactive computer games	2-3 days/week	Use as a complement to aerobics, strength/endurance training, and stretching activities	Balance exercises should be of high intensity (progressively challenging)

Activity Logs

An activity log is a document that describes how, where and when time is spent. One of the most effective ways to identify where time is wasted is to keep an activity diary. Thus, after analyzing the activity logs of people with neurological disorders, they can be directed to do more effective PA by using time more efficiently.²¹

3.3. Wearable monitors

Pedometers, accelerometers, multisensor systems, and smartphone accelerometer are used as wearable monitors to measure PA in people with neurological disorders.²¹⁻²³ Pedometers have the lowest evidence value for use as a tool for exercise prescribing and assessing PA levels in individuals.²² Accelerometers detect acceleration in one, two, or three directions. These devices allow the determination of the amount and intensity of motion.²² Multisensor systems combine with other sensors such as accelerometers that measure data such as heart rate, galvanic skin response, or temperature, providing more data based on PA estimates.^{21,22} A review study, shows that among the wearable monitors, biaxial or triaxial accelerometer type tools worn on the ankle provide the most proper measurement for the group with neurological disorders.² Smartphone accelerometer provides better mobility and disability predictions for both healthy and mobility impaired. Because there is no need for an additional device, the smartphone accelerometer is a more useful, accessible, and accurate device for measuring real-life mobilization for healthy individuals and individuals with chronic disorders.²³

4. Physical Activity Recommendations in Neurological Disorders

When the literature is examined, flexibility, aerobic, muscle strength/endurance, and neuromuscular exercises are listed among the PA recommendations for people with neurological disorders. Aerobic exercises include large muscle activities and functional activities. Muscle strength/endurance exercises comprise trunk using free weights, resistance training of upper-lower extremities, functional mobility, and circuit training. The neuromuscular exercises include balance/coordination exercises, tai chi, pilates, yoga, recreational activities, the active play of video games, and interactive computer games.^{24,25} The frequency, duration, and intensities of these PA/exercise types are shown in Table 1 below.

4.1. Stroke and Physical Activity

Stroke is a clinical picture that can range from loss of motor control and sensory function, balance problems, speech, and cognitive function loss, and visual disturbances to coma, which occurs when cerebral blood flow suddenly decreases or stops.²⁶

Physical activity in stroke lowers blood pressure, body weight, and pulse rate. It raises HDL cholesterol. It lowers LDL cholesterol and improves glucose tolerance by reducing insulin sensitivity. While PA reduces the risk of stroke, it accelerates functional recovery after stroke.²⁷

One of the reasons for the decrease in PA in individuals with stroke is the inability to understand its importance, and the other is the

factors that individuals perceive as barriers to PA participation.²⁸ In addition to psychological and social factors (self-efficacy, beliefs about PA, and social support) physical and environmental factors (lack of professional support and follow-up, transportation difficulties, lack of control, and negative effects) have been reported to be perceived as barriers to PA participation in stroke individuals. Along with all these factors, the individual's functional and motor involvement also affects PA participation but this does not fully explain it. The level of improvement perceived by the individual also plays an important role in adaptation to social life and participation in PA.²⁸

Physical activities including walking, treadmill, stationary bicycle, and bicycle ergometer can be selected as aerobic exercise types in stroke patients. According to the physical fitness level of the patient, it is recommended that each session should be 20–60 minutes (maybe in 10-minute sets during the day) at 50–80% of the max. heart rate 3–7 days a week. Programs should include warm-up and cool-down periods, and vital signs should be monitored during activities.^{29–33}

4.2. Multiple Sclerosis (MS) and Physical Activity

The most common autoimmune disease of the central nervous system is multiple sclerosis.³⁴ MS which is a progressive disease reveals a wide variety of symptoms that vary from person to person. Physical activity is recommended because it can control the symptoms and improve muscle function, aerobic fitness, mobility, and quality of life. Problems such as pain, fatigue, heat sensitivity, and lack of knowledge about PA cause a decrease in PA levels of individuals with MS in the post-diagnosis period, and only less than 20% of patients can reach the recommended PA level.³⁵ Also MS patients often choose not to do PA to avoid fatigue and body temperature rise.³⁴

Participation in PA is one of the most debated topics in the MS literature, and there is a lot of evidence showing the positive effects of structured PA studies including exercise on balance, fatigue, depression, aerobic capacity, muscle strength, and quality of life in individuals with MS.^{35,36} The general recommendation is to perform 30 minutes of moderate-intensity aerobic activity 2 times a week and strengthening exercises involving major muscle groups 2 times a week, depending on the condition of the disease.³⁷ Gradual exercise is recommended to cope with fatigue, and over time the fatigue experienced may decrease. A warm shower after exercise, a cooling suit, air conditioning, or a sunscreen hat can help with heat intolerance.³⁷

A study in individuals with MS showed that self-efficacy is not directly related to PA, but indirectly to goals, barriers, and outcome expectations, providing additional support to social cognitive theory. This study suggests that components of social cognitive theory should address PA involvement and intervention.³⁸

4.3. Parkinson and Physical Activity

Parkinson's disease develops due to the loss of neurons in the substantia nigra from the basal ganglia, the globus pallidus, and the subthalamic nucleus, and the deterioration of the connection between these structures and the motor cortex.³⁹ Parkin-

son's patients have deficiencies at the level of body functions and structures, including tremor, rigidity, bradykinesia, difficulty getting out of bed, and loss of postural control, leading to activity limitations (dressing, getting up from a chair, and walking). These limitations lead to fear of falling, reduced participation in PA, and reduced quality of life.⁴⁰

Various forms of exercise or physiotherapy can maintain and improve mobility by improving daily functioning and decreasing the risk of falls and related injuries. Therefore, early post-diagnosis interventions to promote PA should focus on strength and balance to prevent future falls. A study comparing PA levels in older adults with individuals with Parkinson's found that individuals with Parkinson's are about one-third less active than older adults.⁴¹

A cross-sectional study of 260 Parkinson's patients showed that participants with high self-efficacy were more likely to exercise regularly than those with low self-efficacy.⁴²

4.4. Spinal Cord Injury and Physical Activity

A spinal cord injury overthrows the connections between the brain and the region distal to the injury. This will proportionally affect the individual's ability to be physically active, depending on the level of SCI. A high level of spinal cord injury with complete tetraplegia can make the patient completely dependent on caregivers. So basic PA of these people may be limited to passive movements and stretching made to reduce complications.⁴³

However, an exercise program that addresses how aerobic fitness, muscle strength, coordination, and balance can be improved for lower or incomplete SCI should be created individually. This process should be planned, directed, and managed by expert physiotherapists. The patient and caregivers should be encouraged to continue the physiotherapy program for a long time.⁴⁴

Increased levels of PA in people with SCI significantly decreased fatigue, anxiety, depression, and lower exercise self-efficacy compared to non-disabled controls. Because PA can raise the quality of life for people with SCI, poor exercise self-efficacy is considered a modifiable factor of PA behavior change, especially in this population. Therefore, it is crucial to improve strategies with the capacity to high exercise self-efficacy to increase PA participation and achieve improvements in quality of life.^{44–46}

4.5. Alzheimer's and Physical Activity

Alzheimer's is a chronic progressive disease in which cognitive dysfunction, psychiatric symptoms and behavioral disorders, and difficulties in performing activities of daily living are experienced.⁴⁷ In studies investigating the effectiveness of PA in patients with cognitive disabilities, it has been stated that individuals with mild and moderate cognitive problems have improvements in their general functional levels similar to healthy individuals.⁴⁸ According to a review describing the relationship between improvement in cognitive functions and exercise; there is evidence that PA and exercise have positive effects on cognitive effects, executive functions, memory, attention, and com-

munication in Alzheimer's patients.⁴⁹ However, despite the lack of consensus on applied exercise programs, numerous studies have shown that endurance, balance, and strength exercises can be beneficial.^{49,50}

CONCLUSION

When creating PA programs for people with neurological disorders, it is possible to refer to clinical practice by including the points to be considered. This review examines the importance of PA levels, PA assessments, and exercise recommendations in different neurological disorder groups (Stroke, Multiple Sclerosis (MS), Parkinson's disease, Spinal Cord Injury (SCI), and Alzheimer's disease. Multicomponent aerobic training involving strength, and balance exercises induce crucial beneficial effects on health. Therefore, considering the neurodegenerative feature of neurological disorder, we believe that PA is very important to avoid the progression of both cognitive and motor symptoms of the disease. Physical activity programs should be included in the treatment program of the neurological disorders group.

Comprehensive studies are needed to establish standard protocols and to understand the mechanisms by which PA produces positive effects. However, PA can be overlooked by most people, including those with neurological disorders.

Within the scope of our review, we think that it will raise awareness about increasing PA by emphasizing the importance of PA in the group with neurological disorders. Our review also could be an up-to-date guide that can be used to increase PA in the group with neurological disorders.

For this reason, it is recommended to do regular PA as a preventive measure without having a neurological disorders. In addition, many beneficial effects of regular PA are found in individuals with neurological disorders diagnoses. We suggest further studies that show the positive effects of PA on body systems and encourage doing it by separating people with neurological disorders into specific groups.

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