Multiple Sclerosis and Exercise

Indexing Metadata/Description

› Title/condition: Multiple Sclerosis and Exercise
› Synonyms: Multiple sclerosis, exercise; relapsing-remitting multiple sclerosis and exercise; secondary progressive multiple sclerosis and exercise; primary progressive multiple sclerosis and exercise; progressing-relapsing multiple sclerosis and exercise; MS and exercise; exercise and multiple sclerosis
› Area(s) of specialty: Neurological rehabilitation
› Anatomical location/body part affected: Variable myelinated nerves in the central nervous system (CNS)/motor and sensory deficits can develop in areas served by the affected nerves
› Description
  • Multiple sclerosis (MS) is a chronic immune-mediated, inflammatory disease that destroys the myelin sheaths of CNS white matter. The clinical course of MS is characterized by neurodegenerative decline. Approximately 85% of patients have relapsing-remitting MS, with sudden periods of acute exacerbation (“relapses”) that worsen neurological dysfunction followed by improvement(1,68)
  • MS causes sensorimotor deficits and neurologic weakness that impair mobility in activities of daily living (ADLs)(1)
  • The preponderance of clinical trials in MS support individualized exercise training as an effective, well-tolerated treatment with rare adverse events for reducing disability and improving health-related quality of life (QOL)(2,3,36)
  • In addition, exercise therapy may ameliorate the MS-related fatigue that also limits function in ADLs(4)
  • This Clinical Review provides an overview of the current best evidence for aerobic and/or resistance exercise training in persons with mild to moderate MS. The vast majority of MS patients in research trials on exercise therapy did not have severe disabilities (i.e., Expanded Disability Status Scale [EDSS] scores of 7 or higher; see Overall contraindications, below)
  • See Clinical Review...Multiple Sclerosis (Physical Therapy); Item Number: T708460 for a general review of physical therapy interventions in MS
› ICD-9 codes
  • 340 multiple sclerosis
› ICD-10 codes
  • G35 multiple sclerosis

(ICD codes are provided for the reader’s reference, not for billing purposes)
› G-Codes
  • Mobility G-code set
    – G8978, Mobility: walking & moving around functional limitation, current status, at therapy episode outset and at reporting intervals
    – G8979, Mobility: walking & moving around functional limitation; projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
• Changing & Maintaining Body Position G-code set
  – G8981, Changing & maintaining body position functional limitation, current status, at therapy episode outset and at reporting intervals
  – G8982, Changing & maintaining body position functional limitation, projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
  – G8983, Changing & maintaining body position functional limitation, discharge status, at discharge from therapy or to end reporting

• Carrying, Moving & Handling Objects G-code set
  – G8984, Carrying, moving & handling objects functional limitation, current status, at therapy episode outset and at reporting intervals
  – G8985, Carrying, moving & handling objects functional limitation, projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
  – G8986, Carrying, moving & handling objects functional limitation, discharge status, at discharge from therapy or to end reporting

• Self Care G-code set
  – G8987, Self care functional limitation, current status, at therapy episode outset and at reporting intervals
  – G8988, Self care functional limitation, projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
  – G8989, Self care functional limitation, discharge status, at discharge from therapy or to end reporting

• Other PT/OT Primary G-code set
  – G8990, Other physical or occupational primary functional limitation, current status, at therapy episode outset and at reporting intervals
  – G8991, Other physical or occupational primary functional limitation, projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
  – G8992, Other physical or occupational primary functional limitation, discharge status, at discharge from therapy or to end reporting

• Other PT/OT Subsequent G-code set
  – G8993, Other physical or occupational subsequent functional limitation, current status, at therapy episode outset and at reporting intervals
  – G8994, Other physical or occupational subsequent functional limitation, projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
  – G8995, Other physical or occupational subsequent functional limitation, discharge status, at discharge from therapy or to end reporting

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Source: http://www.cms.gov
Reimbursement: Reimbursement for therapy will depend on insurance contract coverage. No specific issues or information regarding reimbursement have been identified for MS and physical therapy.

Presentation/signs and symptoms
• Age at onset is almost always under 55 years, usually between 20 to 50 years of age\(^1\)
• Patients commonly present with sensorimotor deficits that impact posture, balance, and functional mobility and ambulation
• However, the hallmark of presentation is heterogeneity of symptoms and clinical course varies from case to case\(^1\)
• Global symptoms and complications of MS that should be considered when prescribing exercise include:
  – Atypical and persistent fatigue or MS-related fatigue: this is often described as overwhelming lethargy when trying to complete everyday tasks; independent of weakness or mood\(^2\)
  – Decreased voluntary muscle activation and disuse atrophy (e.g., foot drop)\(^7,8,9,10\)
  – Neurogenic paresis and reduced motor control
  – Episodes of dizziness/vertigo and ataxia
  – Gait changes such as reduced preferred walking speed, and reduced stride length with increased double-limb (dual) support time. Foot drop may affect gait
  – Paresthesias (i.e., sensations of numbness, tingling, and pins-and-needles)
  – Muscle stiffness and spasticity
  – Tremor
  – Blurred vision (usually one of the first signs of MS)\(^1\)
  – Central neuropathic pain\(^11\)
  – Musculoskeletal pain that may be associated with coexisting orthopedic problems (such as contractures)
  – Bladder/bowel problems\(^12,13\)
  – Uhthoff’s phenomenon: exacerbation of symptoms with exposure to heat or increased body temperature. Heat sensitivity may modify exercise prescription\(^14,15\)
  – Abnormal vestibular function, impaired proprioception, and altered balance reactions that increase risk of falls
  – Cognitive decrements (e.g., slowed memory retrieval, reading/writing ability, decreased attention span, reasoning and problem solving)
  – Depressive mood state
• Sensorimotor function is often affected more on one side of the body. This one-sidedness contributes to asymmetric posture and desynchronizes bilateral movements, thus disturbing coordination, balance, and general mobility
• Asymmetry in strength and motor control may present as
  – Joint malalignment
  – Abnormal posture
  – Gait disturbances (e.g., foot drop, monoplegia gait pattern)
  – Muscle stiffness
  – zback, joint, and muscle pain related to postural abnormalities

Causes, Pathogenesis, & Risk Factors

Causes
• The underlying etiology remains unclear, but the disease process is probably triggered by an interaction of genetic and environmental factors/agents\(^16\)
• The HLA-DR15 haplotype has been identified as the main genetic risk factor\(^78\)
• One theory posits that the characteristic demyelination is activated or accentuated by a viral infection\(^16\)

Pathogenesis \(^17\)
• MS is a proinflammatory autoimmune CNS disease that causes the demyelination of nerve cells and destroys oligodendrocytes, neurons and axons\(^16,78\)
• MS symptoms are associated with immunopathologic changes in subcortical white matter. However, the recent finding of grey matter tissue lesions suggests that CNS antigens in addition to myelin proteins may also be involved in MS\(^79\)
• Four distinct clinical subtypes of MS have been identified\(^74\)
– Relapsing-remitting: periodic exacerbations, followed by recovery, which may not be complete. This is the most common subtype (68).

– Primary progressive: the second-most subtype. It is characterized by a steady decline in neurologic function from onset, without episodic flare-ups.

– Secondary progressive: starts as relapsing-remitting, but eventually a progressive deterioration in neurologic function occurs.

– Progressive relapsing: episodic flare-ups leave persistent deficits that do not improve.

– Identifying the clinical subtype has important treatment implications (68).

• Both of the primary subtypes (relapsing-remitting MS and primary progressive MS) follow early thymus gland involution. Reduced thymic output appears to disturb the homeostasis of peripheral naïve CD4 T cells, which then produce an autoimmune response to myelin proteins (16,17).

• Demyelination is always part of the disease mechanism and occurs during inflammatory phases, usually after several active lesions form (16,17).

• Active lesions are associated with T-cell and macrophage-dominated attacks of inflammation (18).

• Heterogeneous, MS lesions (plaques) are diagnostic findings on magnetic resonance imaging (MRI).

• Axonal transection resulting from the demyelination process slows nerve conduction velocity, which reduces sensorimotor function.

• Symptoms that worsen during an attack or relapse such as paresis, blindness, and numbness are probably caused by neuronal conduction block with delayed synaptic transmission.

• Permanent sensorimotor deficits are likely due to irreversible axonal degeneration with severe conduction block.

• Both central and peripheral components have been implicated in MS-related fatigue (60).

  – The central component may be due to abnormal cortical neurotransmission (11,15).

  – Fatigue may be both physical and cognitive, and include a lack of energy, low motivation, physical tiredness, and feelings of exhaustion (60).

• The following pathologies observed in patients with MS may contribute to symptoms of limb muscle fatigue during and following exercise (60).

  – Reduced movement efficiency.

  – Altered corticospinal output during fatiguing muscular activity.

  – Altered functional cortico-muscular coherence.

  – Higher levels of cortical activation for a given muscle force output.

  – Reduced strength and power.

  – Higher levels of muscle fatigability.

  – Reduced muscle oxidative capacity.

• Authors of a small comparison study (n=8 people with relapsing-remitting MS) in the United States found that glucose uptake in leg muscles measured with positron emission tomography (PET) and computerized tomography (CT) imaging during ambulation was not different between the MS patients and the healthy controls (n = 8), despite the asymmetry in leg strength of the patients with MS (75).

  – This suggests that MS biomechanical inefficiency and disability might be more directly caused by alterations in the recruitment of muscle groups and motor patterns generated within the CNS, rather than alterations in leg muscle properties.

• Authors of a 2-group randomized controlled trial (RCT, N = 21 patients with MS) in the United Kingdom found that lack of exercise training may limit exercise capacity more than disease processes (69).

  – Cardiovascular, respiratory, and perceptual responses were monitored during a 12-week continuous (group 1) or interval (group 2) exercise program.

  – Regardless of the type of exercise program, significant increases in peak power and oxygen uptake, as well as improved cardiovascular responses to submaximal exercise, were found. Moreover, the improvement in aerobic function was analogous to responses commonly seen in healthy adults.

• Authors of a survey of 632 patients with MS in Germany found that such relapses were not associated with physical activity or sports participation (5).
Risk factors
• Female gender: prevalence is 2 to 3 times higher than among males\(^{(16)}\)
• Family history of MS\(^{(16,78)}\)
• Anglo-Scandinavian or North Sea ancestry\(^{(16)}\)
• Geographical location of residence before adolescence\(^{(68)}\)
  – Living north of the 37th latitude or in southern latitudes
  - May be related to reduced sunlight exposure during the winter months
• Living in regions with low levels of seasonal sunlight is associated with increased risk of MS in people with vitamin D deficiency\(^{(68)}\)
• Epstein-Barr virus: this and other viral infections may cause proinflammatory events in the CNS that lead to MS symptoms\(^{(19)}\)

Overall Contraindications/Precautions/Recommendations
› Document patient’s functional classification according to the Expanded Disability Status Scale (EDSS)\(^{(20)}\)
  • The EDSS is a widely used tool for scoring MS disability (from 0 to 10) in 8 functional systems (FS): pyramidal, cerebellar, brainstem, sensory, bowel and bladder, visual, cerebral, and other. 0 indicates a normal neurological exam and 10 is death
  • EDSS scores higher than 3.0 indicate impairment of ambulation: EDSS 4.0 (fully ambulatory without aid, self-sufficient, up and about 12 hours a day despite relatively severe disability, which usually involves one FS grade 4; able to walk without aid or rest some 500 meters) to EDSS 7.0 (unable to walk beyond approximately 5 meters even with aid; essentially restricted to wheelchair for over 12 hours a day)
  • Patients with severe disability (EDSS higher than 7.0) may be unsuitable for independent exercise training due to:
    – Inadequate motor control and stability of the trunk
    – Grossly impaired upright postural control and balance
    – Reduced verbal or cognitive function
    – Severe depression or anxiety
› Obtain specific instructions from physician regarding precautions for mobilization of patients with EDSS over 5, and identify what outcomes are expected
› In pediatric cases, obtain written consent from parents or legal caretaker and secure their involvement/commitment to helping with treatment plan
› To maintain adherence, modify the treatment plan as indicated to accommodate the patient’s reported fatigue or discomfort and to increase enjoyable activities. Avoid Uhthoff’s phenomenon in patients with heat sensitivity by avoiding exercise in warm environmental conditions.\(^{(14,15)}\) The most common manifestation of Uhthoff’s phenomenon is blurring of vision
› Postpone treatment and notify physician if increased signs/symptoms suggest the occurrence of an attack or relapse of MS demyelination
› The presence of a deep vein thrombosis (DVT) that might be due to a co-existing musculoskeletal condition is a contraindication to exercising the involved limb or joint
› See specific Contraindications/precautions to examination and Contraindications/precautions under Assessment/Plan of Care

Examination
› Precautions/recommendations to examination
  • The patient’s fatigue may prevent completing the exam in one appointment
  • Examine patients with MS in a cool, calm, and quiet room (with air-conditioning, dimmed lights, soft music)
  • Allow patient to rest between tests as indicated
› History
  • History of present condition: When was MS diagnosed? How have symptoms developed over time? “The hallmark of MS is the development of symptoms disseminated in space and time”\(^{(16)}\)
    — Course of treatment
    - Medical management: Document course of treatment for this referral. Medical management may include medications (see below for more details), treatment of secondary complications (e.g., skin breakdown), and symptom management
- **Medications for this condition:** Obtain a complete list of prescribed medications that are currently being taken
  - Specific MS disease-modifying medications include interferon-beta 1a and 1b (e.g., Avonex, Rebif, Betaseron, Extavia, Plegridry), immunomodulators (e.g., glatiramer acetate [Copaxone], monoclonal antibodies (e.g., natalizumab [Tysabri]), and immunosuppressants (e.g., cyclophosphamide [Cytoxan], azathioprine [Imuran])\(^{(1)}\)
  - Many disease-modifying drugs are administered parenterally. U.S. Food and Drug Administration (FDA) approval of three oral disease-modifying drugs—fingolimod, teriflunomide, and dimethyl fumarate—has provided more options for relapsing-remitting MS that are as efficacious as the more established parenteral treatments\(^{(72)}\)
  - Corticosteroids (e.g., dexamethasone) are used to relieve systemic inflammation
  - Hypertonicity/spasticity may be treated with baclofen, dantrolene, botulinum toxin type A injections, or gabapentin
  - Antidepressants are commonly prescribed to treat anxiety and depression in MS
  - Medications for bladder and bowel dysfunction may include botulinum toxin, tamsulosin (Flomax), tolterodine (Detrol), docusate (Colace), and bisacodyl (Dulcolax)
  - The patient may also be medicated for pain, such as with ibuprofen, paracetamol, or naproxen. Back, joint, and muscle pain are common in MS due to altered posture and joint position\(^{(21)}\)
  - Immunomodulatory drug therapy is associated with improved outcomes\(^{(18)}\)
  - Monoclonal antibody therapies that target T-cells and/or B-cells appear to ameliorate symptoms by suppressing the autoimmune pathology\(^{(18)}\)

- **Diagnostic tests completed:** Diagnostic testing may include MRI, blood tests, urinalysis, CSF analysis, and evoked potentials. Document the results of any testing completed

- **Home remedies/alternative therapies:** Document any treatment at home or alternative therapies for pain (e.g., massage, acupuncture) or fatigue (e.g., work efficiency counseling) that were tried and whether or not they helped
  - Authors of a 2014 meta-analysis found that complementary and alternative medicines (CAMs) used for treating spasticity and pain symptoms in MS include cannabis, magnetic therapy, fish oil, ginkgo biloba, reflexology, Cari Loder regimen, and bee sting therapy\(^{(61)}\)
  - Overall CAM quality control and regulation is of concern, and some CAMs may cause adverse effects. Interactions of some CAMs with disease-modifying therapies in MS may be unknown\(^{(61)}\)

- **Previous therapy:** What occupational/physical therapy has the patient already received for this condition and what specific treatments were helpful or not helpful? Has the patient received in-hospital rehabilitation or home care?
- **Aggravating/easing factors:** Document factors that aggravate symptoms, such as pain or fatigue during ADLs, and the factors that improve them. Patients are commonly sensitive to heat and excessive activity
- **Body chart:** Use body chart to document location and nature of symptoms
- **Nature of symptoms:** Ask the patient to describe major symptoms, which may include pain, vertigo, blurred vision, and bowel/bladder problems. If the patient experiences muscle fatigue, weakness, tingling, numbness, stiffness, edema, spasticity, and cramps, where are these symptoms located?
- **Rating of symptoms:** Use a visual analog scale (VAS) or 0-10 scale to assess symptoms at their best, at their worst, and at the moment (specifically address if pain is present now and how much)
- **Pattern of symptoms:** Document changes in symptoms throughout the day and night, if any (A.M., mid-day, P.M., night); also document changes in symptoms due to weather or other external variables
- **Sleep disturbance:** If present, document the usual number of wakings/night, which may occur due to spasticity, spasms, or nocturia\(^{(59)}\)

- **Other symptoms:** Document other symptoms patient may be experiencing that increase disability in ADLs and/or indicate need for medical consultation (e.g., severe headaches, night sweats, new edema, rash)
- **Respiratory status:** Any known respiratory compromise? Respiratory muscle weakness? Does the patient smoke? What is the patient’s reported level of participation in physical activity? What are the barriers to physical activity?
- **Barriers to learning**
  - Are there any barriers to learning? Yes ___ No ___
  - If Yes, describe ________________

- **Medical history**
  - **Past medical history**
  - **Previous history:** What is the patient’s history of MS and clinical course (i.e., history of mobility and independent function)?
- Comorbid diagnoses: Ask patient about coexisting problems, including diabetes, cancer, heart disease, psychiatric disorders, musculoskeletal disorders, chronic lung disease, etc.

- Medications previously prescribed: Obtain a comprehensive list of medications taken for other health problems (including over-the-counter drugs)

- Other symptoms: Ask about other symptoms that have affected the patient’s mobility in ADLs

**Social/occupational history**

- Patient’s goals: Document patient’s expectations/goals for outcomes after treatment. What social or occupational roles does the patient expect treatment will improve?

- Vocation/avocation and associated repetitive behaviors: Is the patient currently on work disability? Did the patient participate in recreational activities or sports prior to this referral? What are patient’s goals for return to activity? How much daily physical activity does the patient typically perform?

- Studies have shown that people with MS engage in less physical activity than typical adults, particularly if the disease is more severe

- Functional limitations/assistance with ADLs/adaptive equipment: Is the patient independent in self-care and mobility at home? Document assistive devices that are being used; e.g., cane, crutches, wheelchair, knee-ankle-foot orthosis (KAFO), standing frame, lift

- Living environment: Identify barriers to mobility in the home and whether any modifications are necessary (e.g., stairs, number of floors in home, lack of caregivers). What support system (family/caregiver) is available? Access to community supports?

**Relevant tests and measures: (While tests and measures are listed in alphabetical order, sequencing should be appropriate to patient medical condition, functional status, and setting)**

- **Assistive and adaptive devices:** Is a functional orthosis or ambulatory assistive device used? Assess fit of prescribed splinting/bracing or orthosis (e.g., ankle-foot orthosis [AFO]). Assess use and management of assistive devices, including those for bathing and toileting

- **Balance:** Static and dynamic balance are commonly impaired. Assess for ankle sway in standing, balance and postural synergy reactions in standing, and balance in tandem gait. Administer functional reach tests. The Berg Balance Scale was found to be effective for screening postural balance problems in MS.

- The Activities-specific Balance Confidence (ABC) Scale may help to explain disability in ambulatory tests such as the 6-minute walk for distance test (6MWT)

- **Cardiorespiratory function and endurance:** Assess and monitor vital signs, including heart rate (HR), blood pressure (BP), breathing, and Borg Rating of Perceived Exertion (RPE). HR and BP levels during physical activities that are much lower than expected for the patient’s reported perceived exertion level might indicate autonomic dysregulation.

- The Borg RPE Scale may be insensitive to subtle changes in physiological exercise stressfulness for this particular population. The 6MWT may be used to assess endurance performance in ambulatory patients; however, this test may have limitations in the MS population

- Authors of a cohort study (N = 160 persons with MS) in the United States found that different amounts of energy were expended during the 6MWT depending on how it was administered

- Participants completed a 6MWT while wearing a portable metabolic unit to measure oxygen uptake. Tests were conducted in either a single corridor that required 180° turns (n = 78) or in a square hallway with 4 corridors requiring 90° turns (n = 82). The participants who had to complete 180° turns expended more energy

- Authors of a comparison study (N = 44) in Australia found that people with MS show signs of fatigue after the 6MWT, including strength and balance deficits, that could have implications for mobility and for fall risk

- Thirty-four people with MS and 10 healthy controls underwent assessments of acute fatigue, postural sway, and lower limb strength before and after 6 minutes of sitting and 6MWT

- The 6MWT induced fatigue with associated increases in postural sway and decreases in lower limb strength in the MS group. Increases in sway with eyes closed correlated with increases in acute fatigue and with self-reported impact of fatigue on physical and psychological functioning. No significant changes occurred in the control group

- This study points out the need for clinicians to be aware of the sensitivity of clinical measures (e.g., balance, strength, fatigue) to change after vigorous walking in people with MS

- The 6MWT may increase sway and greater reported fatigue when conducted in the late afternoon compared to testing in the morning

- Based on a study in the United States that involved 15 ambulatory patients with MS and moderate disability
- The need for clinicians and researchers to consider controlling for factors such as time of day and prior physical activity when administering standardized measures in people with MS was noted
- Use of step rates to measure intensity of physical activity in persons with MS may be inaccurate in patients with walking impairments
- Since direct measurement of activity intensity by measurement of metabolic equivalent units (METs) is expensive and impractical, indirect measures such as step rates are often used
- Based on a study in the United States, step-rate thresholds developed in healthy people without disabilities may not apply to people with MS because
- persons with MS, especially those with higher levels of walking impairment, have lower step-rate thresholds for moderate- to vigorous-intensity exercise than people without MS
- consequently, physical activity levels in people with MS should not be graded on step rates developed for healthy people
- Authors of a 2015 systematic review and meta-analysis found that aerobic capacity in people with MS was impaired compared to healthy people, and was significantly associated with factors on all levels of the International Classification of Functioning, Disability and Health (ICF) model, including disease severity
- A total of 40 studies, involving 165 healthy controls and 1,137 people with MS were included
- VO2max testing was determined to be a valid measure of aerobic capacity in people with MS having low-to-mild disability, and a 10% change between 2 tests performed on separate days can be considered the smallest reliable change in VO2max in people with MS

**Circulation**: Assess peripheral pulses

**Cranial nerve integrity**: Assess for deficits in cranial nerve function
- Olfaction (CN I): Can the patient smell coffee or soap with each nostril?
- Vision (CN II): Can the patient see an eye chart equally with each eye? Are the pupils equally reactive to light and accommodation?
- Extraocular movements (CN III, IV, VI): Can the patient look in all directions, keeping the head still, without experiencing any double vision?
- Facial sensation (CN V): Can the patient feel a cotton wisp equally on each cheek?
- Facial expression (CN VII): Assess for asymmetry in facial contour and wrinkles when patient is asked to smile, puff out cheeks, clench eyes tight
- Articulation (CN V, VII, IX, X, XII): Is the patient’s speech slurred, quiet, breathy, nasal, low or high-pitched?
- Tongue protrusion (CN XII): Can the patient stick tongue straight out and move it equally from side to side?
- Auditory (CN VIII): Assess for hearing loss

**Ergonomics/body mechanics**: Observe patient for efficiency/coordination in general mobility and use of optimal body mechanics to maximize independence

**Functional mobility**: If indicated, assess bed mobility and ability in transfers, especially if upper extremities are involved. Observe patient’s gross movement in functional tasks, paying close attention to the more involved upper extremity (e.g., reaching, pulling, pushing, holding) and/or lower extremity (e.g., steps, squatting, kneeling, kicking). Authors of a comparison study (N = 33) in the United States found that poor performance in the sit-to-stand test may be due to quadriceps weakness, and use of a trunk-flexion movement strategy during the sit-to-stand test likely indicates reduced leg strength. Assess mobility in the Timed Up-and-Go (TUG) Test

**Gait/locomotion**: Assess walking ability or, if applicable, wheelchair mobility
- Assess synchrony of limb movements and gait speed and mechanics during ambulation
- Assess posture in walking
- Common gait deviations include foot drop and monoplegia gait pattern
- Persons with MS may exhibit atypical knee and ankle joint angles during stance phase
- Assess for altered gait parameters, including:
  - Slow preferred walking speed, which is associated with increased aerobic cost (decreased efficiency) of walking
  - Longer dual support time
  - Stride width is often narrower due to adductor spasticity
- The Dynamic Gait index (DGI) is a valid measure of balance during gait in patients with MS
The 12-Item MS Walking Scale (MSWS-12) is a valid measure of the impact of MS on walking ability. Authors of a study in the United States found that plantar flexor weakness negatively impacts walking more than plantar flexor spasticity in persons with MS. Plantar flexor strength was the most consistent predictor of variance in walking ability as assessed by self-perceived limitation of walking (12-Item MS Walking Scale), the 25-foot walk test, and the 6MWT. There were no significant differences between participants with and without plantar flexor spasticity for the outcomes measured. Authors of a comparison study in Denmark found that preferred walking speeds in the 10-meter timed walk test (10mWT) and 6MWT were found to be strongly correlated in persons with MS (n = 38), suggesting that the shorter test may serve as a useful outcome measure of gait speed.

Timed 25-foot walk test is typically used in MS testing and is 1 of 3 components of the Multiple Sclerosis Functional Composite (MSFC). The other 2 are the 9-Hole Peg Test and the Paced Auditory Serial Addition Test (PASAT).

- **Joint integrity and mobility:** Assess joint mobility in the affected limb(s), especially if indicated by impaired ROM or movement limitation in functional tasks.
- **Motor function (motor control/tone/learning):** Assess for the presence of hypertonicity/spasticity, especially in the gastrocnemius-soleus, using modified Ashworth Scale (MAS). Assess coordination of bilateral movement of the extremities and with rapid alternating movements.
- **Muscle strength:** Scan for weakness in the affected muscle(s). Assess strength in the trunk, upper and lower extremities using manual muscle testing (MMT) if no abnormal tone or coordination is present, and compare bilaterally. Measure circumference of affected limb if muscle atrophy appears present. Assess grip strength if hand is involved.
- **Observation/inspection/palpation**
  - Observe for bilateral asymmetry in joint alignment.
  - Inspect for muscle atrophy.
  - Palpate for muscle contracture in the affected limbs.
  - Check skin for pressure sores due to immobility.
- **Pain/tenderness:** Assess pain intensity and fatigue intensity with VAS. Assess the involved soft tissues for tenderness. Observe for increased fatigue in warm conditions (i.e., Uhthoff’s phenomenon), especially during exercise. Does patient report increased pain or fatigue with specific activities during the exam?
- **Posture:** Assess body alignment and observe for postural asymmetry in positioning of the head, shoulders, torso, hips, knees, and feet in sitting and standing. Correlate deviations in posture with abnormal findings on motor function, strength, and flexibility.
- **Range of motion:** Assess range of motion (ROM) and flexibility of the involved joints and, if applicable, compare to contralateral limb. Is ROM impaired by contracture or spasticity?
- **Reflex testing:** Reflexes are commonly abnormal. Assess deep tendon reflexes (biceps, triceps, brachioradialis, quadriceps, and Achilles) for an exaggerated response.
- **Sensation:** Sensation is commonly impaired. Assess proprioception and sensitivity to pinprick, light touch, and temperature, as indicated.
- **Special tests**
  - The ABC Scale and the Functional Stair Test (FST) were found to correlate significantly with performance in the 6MWT at a self-selected pace considered “as quickly and safely as possible.”
  - Authors of a study of (n = 59 patients with mild disability, median EDSS 1.5) in Canada found that a multistage step test to 85% of maximum age-predicted HR and a hand dynamometer grip test explained 74% of the variance in peak oxygen consumption (VO2peak) on incremental cycle ergometer testing.
  - The Modified Fatigue Impact Scale (MFIS), a 21-item questionnaire, can be used to assess the impact of MS-related fatigue on physical, cognitive, and social functioning.

### Assessment/Plan of Care

**Contraindications/precautions**

- Patients with MS are at risk for falls; follow facility protocols for fall prevention and post fall prevention instructions at bedside, if inpatient. Ensure that patient and family/caregivers are aware of the potential for falls and educated about fall prevention strategies. Discharge criteria should include independence with fall prevention strategies.
• Exercise contraindications/precautions
  – The heterogeneity of MS symptoms from case to case mandates that exercise interventions should be tailored to each patient’s needs and lifestyle
  – Monitor for exercise-related adverse symptoms (e.g., hypotension in patients with autonomic dysregulation; blurred vision or increased fatigue in patients with Uhthoff’s phenomenon) and modify the exercise training program accordingly. For example, a patient who reports lightheadedness during exercise while standing may feel better if the exercise is performed in a semi-recumbent or sitting position
  – Avoid ballistic passive or active stretching of limbs as it may worsen hypertonicity/spasticity
  – The activity prescription should always be modified as needed to minimize exercise-induced MS symptoms
  – Patients with MS may experience delayed recovery of leg fatigue symptoms following exercise
    - Based on a study conducted in the United Kingdom that compared symptoms of fatigue in 58 persons with MS and 15 healthy low-active controls
    - Following exercise to voluntary exhaustion on a cycle ergometer, feelings of leg fatigue were higher throughout the recovery period in persons with MS than in the healthy controls
    - These findings suggest that leg fatigue recovery could be used as a guide to appropriate exercise prescription without increasing chronic fatigue
    - Consideration should be given to the recovery of leg fatigue symptoms when prescribing intensity and dose of exercise and in scheduling frequency of sessions
  – The subjective intensity of exercise can be monitored with the Borg RPE Scale. A targeted RPE of “very, very light” (7/20) to “very light” (9/20) is appropriate for the first week of training, then progressed to “fairly light” (11/20) in weeks 2 and 3, provided the exercise is well-tolerated. Thereafter, the RPE can usually be maintained at “fairly light” to “somewhat hard” (13/20), according to patient tolerance
  – Workshops that enhance self-efficacy may be associated with more enjoyment and greater adherence of programmed exercise
  – Exercise prescription should incorporate enjoyable exercise modalities such as that reported for aquatic therapy; avoid warm pool temperature for patients with heat sensitivity
  – Wearing a cooling vest may enhance exercise performance in heat-sensitive patients
  – Sedentary adults with mild MS reported RPE levels similar to sedentary adults without MS during cycle ergometer exercise at 25%, 50%, 75%, and 100% of VO2peak, although the MS group reported higher fatigue scores. Additional subjective factors such as fatigue and heat stress should therefore be monitored to optimize exercise intensity for each patient

• Clinicians should follow the guidelines of their clinic/hospital and what is ordered by the patient’s physician. The summary below is meant to serve as a guide, not to replace orders from a physician or a clinic’s specific protocols
• Evidence is lacking on the effectiveness of physical or electrotherapeutic modalities for pain relief in patients with MS. However, practitioners should observe the following contraindications and precautions if modalities are used for musculoskeletal symptoms

• Cryotherapy contraindications
  – Raynaud’s syndrome
  – Medical instability
  – Cryoglobulinemia
  – Cold urticaria
  – Paroxysmal cold hemoglobinuria
  – Avoid applying cold over superficial nerves, areas of diminished sensation or with poor circulation, or slow-healing wounds

• Cryotherapy precautions
  – Use caution with patients who are hypertensive as cold can cause a transient increase in BP; discontinue treatment if there is an elevation in BP
  – Use caution with patients who are hypersensitive to cold
  – Avoid aggressive treatment with cold modalities over an acute wound
  – Use of cryotherapy with patients who have an aversion to cold may be counterproductive if being used to promote muscle relaxation and decrease pain
• **Superficial heat** contraindications\(^{(30)}\)
  – Uhthoff’s phenomenon\(^{(14,15)}\)
  – Decreased circulation
  – Decreased sensation
  – Acute/subacute traumatic and inflammatory conditions
  – Skin infections
  – Impaired cognition or language barrier
  – Tumor present in area
  – Tendency for hemorrhage or edema
  – Heat rubs

• **Aquatic therapy** contraindications\(^{(30)}\)
  – Uncontrolled seizure activity
  – Unstable medical conditions
  – Severe cardiac precautions
  – Acute fever
  – Infectious diseases (e.g., the flu), upper respiratory infections
  – Severe pulmonary conditions (e.g., vital capacity < 1 L)
  – Behavior that creates safety concerns
  – Phobia of water
  – Open wounds (without proper occlusive dressings)
  – Incontinence
  – Skin infections

• **Aquatic therapy** precautions
  – Heat intolerance
  – At this time, there is no definitive research supporting water temperature guidelines for aquatic therapy for MS. The general recommendation is for water temperature to be between 80° and 86°F (27° and 30°C)\(^{(23)}\)
  – Orthostatic hypotension

• **Whirlpool** contraindications\(^{(30)}\)
  – Severe epilepsy
  – Certain dermatologic conditions
  – Surface infections
  – Uncontrolled bowels
  – Acute rheumatoid arthritis
  – Venous ulcers
  – Tissues devitalized by radiation therapy
  – Peripheral vascular disease
  – Decreased thermal sensation
  – Respiratory dysfunction
  – Cardiac dysfunctions
  – Active bleeding
  – Tumor present
  – Recent fever
  – Acute inflammatory conditions

• **Whirlpool** precautions (*some are only relevant if entire body is immersed*)\(^{(30)}\)
  – Heat sensitivity
  – Impaired sensation
  – Confusion or impaired cognition
  – Recent skin grafts
  – Certain medications
  – Alcohol intoxication
  – Decreased strength/ROM/endurance/balance*
• Urinary incontinence*
• Fear of water*
• Respiratory problems
• Pregnancy*
• Multiple sclerosis*
• Poor thermal regulation*
• Seasickness
• Edema, when warm/hot water immersion

Electrotherapy contraindications/precautions (in some cases, **when approved by the treating physician**, electrotherapy may be used under some of the circumstances listed below when benefits outweigh the perceived risk) \(^{(30)}\)

• Stimulation through or across the chest
• Cardiac pacemakers
• Implanted stimulators
• Over carotid sinuses
• Uncontrolled hypertension/hypotension
• Peripheral vascular disease
• Thrombophlebitis
• Pregnancy
• Over pharyngeal area
• Diminished sensation
• Acute inflammation
• Seizure history
• Confused patients
• Immature patients
• Obesity
• Osteoporosis
• Used in close proximity to diathermy treatment

Therapeutic ultrasound contraindications\(^{(30)}\)

• Over the region of a cardiac pacemaker
• Over the pelvis, abdominal and lumbar regions during pregnancy
• Over the eyes and testes
• In an area with infection or bleeding
• If a tumor or malignancy is present in the area
• In the area of a DVT or thrombophlebitis
• Over the heart, stellate or cervical ganglia
• Over epiphyseal plates of growing bones

Therapeutic ultrasound precautions\(^{(30)}\)

• Use caution in patients with sensory deficits and in patients who are unable to communicate sensory deficits
• Use caution if patient has circulatory impairments
• Use caution over plastic or metal implants
• Always decrease ultrasound intensity if the patient complains of discomfort

› **Diagnosis/need for treatment:** MS/impaired mobility due to sensorimotor deficits, fatigue, decreased ROM, decreased strength and endurance, and functional deficits in posture, balance, and gait; associated disabilities in ADLs; pain

› **Rule out:** Amyotrophic lateral sclerosis (ALS), Guillain-Barré syndrome, chronic fatigue syndrome, and numerous other conditions that can damage myelin, including viral infections (e.g., Epstein-Barr virus), exposure to certain toxic materials, severe vitamin B12 deficiency, autoimmune conditions that lead to inflammation of blood vessels (collagen-vascular diseases), some rare hereditary demyelinating disorders (e.g., Devic’s disease, Balo’s disease, Schilder’s disease), stroke, chronic inflammatory demyelinating polyneuropathy

› **Prognosis**

• Disease progression is disseminated (irregular and unpredictable in time and location) and highly variable among patients\(^{(1)}\)

• In most cases, daily physical activity and functional mobility progressively decline over time\(^{(7,8,9,10)}\)
• Worsening of symptoms is associated with lower physical activity levels and slowing of preferred walking speed

• At least over the short-term, exercise training is associated with enhanced mobility and QOL

• Authors of a pilot randomized controlled trial (RCT, N = 30 persons with MS) found that the improved QOL and reduced fatigue that resulted from 3 months of exercise training persisted for 3 months after the exercise program was discontinued despite an observed decline in physical capacity

› Referral to other disciplines: Occupational therapist, especially for patients restricted to a wheelchair (EDSS scores 7.0 and higher) or for disability in instrumental ADLs; acupuncturist or pain management specialist for chronic pain management; psychiatrist for anxiety/stress disorder; orthotist for custom splint or brace; orthopedist for ongoing joint pain; recreational therapist for supervised group exercise; aquatic therapist for pool exercise program; social services for equipment and home needs

› Other considerations

• Although exercise training, dietary, and stress management interventions have each been shown to improve health-related QOL in persons with MS, exercise may have the strongest positive effect in those with less functional disability

• In addition to the impairment(s) associated with MS, common barriers to exercise include being too tired and lack of time

• Authors of a survey of 417 persons with MS in Canada found little evidence to recommend that exercise interventions should be gender-specific

• Authors of a study (N = 59 people with MS in a cognitive rehabilitation program) in Finland found that personal goals set using the Goal Attainment Scaling (GAS) method and mapped according to the International Classification of Functioning, Disability, and Health (ICF) covered areas missed by standardized outcome measures

› Treatment summary: Most research subjects studied in trials on exercise training had mild to moderate MS-related disabilities and were able to walk at least 100 meters without assistance and to exercise independently with close supervision. The consistent finding has been that aerobic or resistance exercise programs, or both, can effectively improve physical functioning in patients with an EDSS score from 1.0 (no disability) to 6.0 (intermittent or constant unilateral ambulatory assistance required to walk about 100 meters with or without resting)

• Overview of exercise prescription in MS
  – Virtually all trials to date have applied the standard principles of exercise prescription used to improve health-fitness in the general population, with modifications as indicated to accommodate each patient’s special needs
  – Maximal and optimal exercise training doses (i.e., intensity, duration, and frequency) have not been established for people with MS because in practice, patients may demonstrate functional benefits from very low exercise doses. On the other hand, greater training benefits may be obtained from higher exercise doses if well tolerated. The heterogeneous responses to different exercise doses is poorly understood
  – Authors of a 2015 systematic review and meta-analysis indicate that aerobic training can improve aerobic capacity in people with MS to a degree that is associated with secondary health benefits
    - A total of 40 studies with 165 healthy controls and 1,137 people with MS were included. Aerobic capacity was measured with VO2max testing
    - Meta-analysis showed that aerobic training might improve VO2max by as much as 3.5 mL/kg/min, or more than 15%
  – Authors of 2013 and 2014 systematic reviews on exercise in MS found that exercise can improve cardiovascular endurance, strength, functional mobility, motor skills, gait, QOL, and fatigue
  – Exercise prescription for improving functional mobility is supported by a 2005 systematic review of 9 trials that included 260 participants. Meta-analysis of data from these trials suggests that prescribed aerobic and resistive exercise training promotes walking ability
  – Authors of an RCT (N = 24 persons with moderate MS-related mobility impairments) in Italy found that high-intensity task-oriented circuit class training followed by a home-based exercise program was feasible and safe and resulted in improved walking ability and QOL
  – The experimental group received ten 2-hour circuit training sessions over 2 weeks followed by a 3-month home exercise program, while the control group did not receive any specific rehabilitation intervention
  – Outcome measures included 6MWT, 10MWT for gait speed, TUG test for mobility, and DGI for balance. Self-reported questionnaires were used to assess fatigue (the FSS), walking ability (the MS Walking Scale) and QOL (MS Impact Scale)
- Walking ability and QOL were significantly improved at completion of the training program, with some retention after 3 months when adherence to the exercise program was 58.33%.

  - Authors of an RCT (N = 99 persons with MS) in Turkey found that those randomly assigned to 12 weeks of group exercise improved balance, gait, fatigue, and QOL more than a wait-listed control group.

  - Authors of an RCT (N = 32 women with MS) in Iran found that those who participated in 8 weeks of aquatic exercise improved their fatigue and health-related QOL compared to controls who continued their current treatment without exercise.

- Outcome measures included the MFIS and the Multiple Sclerosis Quality of Life-54.

- The aquatic exercise program was conducted 3 times per week for 8 weeks for 1 hour and consisted of cardiovascular, balance, stretching, and strengthening exercises and ambulation.

- Use of a paid professional caregiver specifically employed to work on prescribed home-exercise programs may benefit patients with MS as well as their caregivers.

- Based on a study of a model of care delivery that employs “exercise buddies” conducted in Ireland.

- Exercise buddies worked under the guidance of a physiotherapist who prescribed a home exercise program for the person with MS.

- The appropriate and adequate training of exercise buddies was identified as a crucial element for the success of this program.

- Standardized outcome measures were not used; however, qualitative analysis identified both physical and psychological benefits.

• Overview of progressive resistance training (PRT) benefits in MS

  - Authors of a crossover-design study (N = 16) in Australia found that aerobic training and PRT were both well tolerated and each promoted similar improvements in physical functioning (e.g., functional reach, TUG test, and 6MWT).

  - Increased leg strength in 15 moderately impaired patients (EDSS scores between 3.0 and 5.5) after intense PRT was associated with improved ambulatory function.

  - Based on a RCT conducted in Denmark.

  - PRT consisted of 10 to 12 repetitions (2 to 3 sets) on 5 conventional weight machines (leg press, knee extension, hip flexion, hamstring curl, hip extension), 2 times/week (Monday and Thursday), for 12 weeks.

  - Functional tests included chair stand, stair climbing, 10mWT, and 6MWT.

  - The effects of training persisted after 12 weeks of self-guided physical activity.

  - Authors of a study (N = 13 patients with EDSS scores ranging from 1.0 to 6.0) in Spain found that thigh muscle strength, endurance, power, and cross-sectional area on MRI increased after 8 weeks of moderate-intensity PRT.

  - Testing and training were performed on a leg extension machine.

  - The intensity of PRT ranged from 40% to 70% of maximal voluntary contraction.

  - 3 sets of 10 to 15 repetitions per session, 2 sessions per week.

  - Authors of a study (N = 67 participants with MS) in the United States found that a 6-month program of PRT (50 minutes per session, 2 sessions per week) was effective for improving strength and muscular endurance independent of EDSS score.

  - 27 patients (40%) had scores of 1.0 to 4.5; 23 (35%) had scores of 5.0 to 7.0; and 17 (25%) had scores of 7.5 or 8.0.

  - Unfortunately, the impact of observed improvements in strength and endurance on functional mobility were not reported.

  - However in their a prior study, these researchers found that balance (Berg Balance Scale), gait mechanics (3-D gait-analysis system), and MS-related fatigue (MFIS) improved following the same PRT protocol. EDSS scores in this prior study (N = 33) ranged from 1.0 to 6.5.

  - Authors of an RCT (N = 42 participants with MS) in Spain found that 12 weeks of no exercise after 12 weeks of PRT reduced maximal isometric strength to pretraining levels.

  - Outcomes measured included knee extension maximal voluntary isometric contraction (MVIC), muscle power, and muscle endurance.

  - Resistance training resulted in increased MVIC and muscle power but did not increase muscle endurance.

  - After 12 weeks of detraining MVIC returned to pretraining values, although muscle power remained higher than pretraining values.

  - Authors of a study (N = 14 participants with a history of frequent falls) in Turkey found that a 2-month program of PRT on a stationary cycle ergometer was associated with improved functional outcomes.
- PRT consisted of 16 training sessions (2 times per week) of high-resistance pedaling (40% of maximum tolerated workload)
- 15 sets per session of pedaling for 2 minutes, each set followed by 2 minutes of recovery
- Participants also performed 20 to 25 minutes of balance exercises per session
- Outcome measures that improved were cycling performance, TUG test, DGI, functional reach, FIS, and Falls Efficacy Scale

Home-based exercise may be a feasible, safe, and effective way for reducing fall risk in older adults with MS(67)

- Based on a pilot RCT conducted in the United States
- Older adults with MS were randomly assigned to either a home-based exercise intervention group (n = 13) or a waiting list control group (n = 14)
- The exercise group participated in lower extremity muscle strengthening and balance exercises 3 times per week for 12 weeks. Exercise was individualized and performed unsupervised. Compliance logs were monitored. The control group continued normal activity
- Outcomes measured included fall risk (Physiological Profile Assessment scores), balance (Berg Balance Scale), and walking
- Fall risk was found to decrease in the exercise group, while there was an increase in fall risk in the control group

Authors of an RCT (N = 19 patients with mild to moderate disability, mean EDSS = 5.2) in the United States found that increasing the eccentric (E) phase during lower-extremity weight lifting did not produce greater strength or functional gains compared to a standard (S) lifting group or controls(47)

PRT consisted 3 sessions per week for 12 weeks
- Results for TUG test, 10mWT, stair climbing, 6MWT, Berg Balance Scale, and Fatigue Severity Scale were not different between the E and S groups after PRT

PRT combined with balance training on a vibration plate improved single-leg balance and decreased 10mWT in a convenience sample of 12 Iranian women with MS compared to 12 controls who did not exercise (48)

<table>
<thead>
<tr>
<th>Problem</th>
<th>Goal</th>
<th>Intervention</th>
<th>Expected Progression</th>
<th>Home Program</th>
</tr>
</thead>
</table>
| Reduced mobility that involves deficits in balance, flexibility, strength, and gait, and MS-related fatigue(56) | Improve strength and endurance for secondary functional gains, including balance, functional mobility, and ability to ambulate | **Therapeutic exercise**
- Individualized aerobic(52) and/or resistance exercise training, PRT | Individualized progression of exercise frequency, intensity, and duration, as tolerated; monitor for fatigue and heat sensitivity | Home program for daily repetition of independent exercises |

### Desired Outcomes/Outcome Measures

- Increased strength/ dynamometer or MMT
- Improved endurance/ 6MWT, graded exercise test on treadmill or cycle ergometer
- Improved balance/ BBS, ABC Scale, Functional Reach
- Reduced fall risk/ Physiological Profile Assessment (PPA) to assess fall risk, DGI
- Reduced MS-related fatigue/ Fatigue Severity Scale, MFIS
- Improved walking speed, ambulatory ability and safety/ DGI, gait analysis, 10mWT, Timed 25-foot walk test, MSWS-12
- Improved QOL/ Short Form-36 Health Questionnaire
- Increased flexibility/ goniometer
- Improved functional mobility/ TUG test, FST
# Maintenance or Prevention

- Maintain active lifestyle
- Continue prescribed aerobic and strength exercise training
- Continue prescribed functional training
- Environmental modifications and patient education to prevent falls
- Prevention of fatigue
- Prevention of overheating – e.g., environmental adaptations such as air conditioning

# Patient Education


## Coding Matrix

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>Published meta-analysis</td>
</tr>
<tr>
<td>SR</td>
<td>Published systematic or integrative literature review</td>
</tr>
<tr>
<td>RCT</td>
<td>Published research (randomized controlled trial)</td>
</tr>
<tr>
<td>R</td>
<td>Published research (not randomized controlled trial)</td>
</tr>
<tr>
<td>C</td>
<td>Case histories, case studies</td>
</tr>
<tr>
<td>G</td>
<td>Published guidelines</td>
</tr>
<tr>
<td>RV</td>
<td>Published review of the literature</td>
</tr>
<tr>
<td>RU</td>
<td>Published research utilization report</td>
</tr>
<tr>
<td>QI</td>
<td>Published quality improvement report</td>
</tr>
<tr>
<td>L</td>
<td>Legislation</td>
</tr>
<tr>
<td>PGR</td>
<td>Published government report</td>
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<tr>
<td>PFR</td>
<td>Published funded report</td>
</tr>
<tr>
<td>X</td>
<td>Policies, procedures, protocols</td>
</tr>
<tr>
<td>GI</td>
<td>General or background information/texts/reports</td>
</tr>
<tr>
<td>U</td>
<td>Unpublished research, reviews, poster presentations or other such materials</td>
</tr>
<tr>
<td>CP</td>
<td>Conference proceedings, abstracts, presentation</td>
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</tbody>
</table>

## References


