35. Multiple sclerosis

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Summary

Maintaining muscle activity, strength and aerobic fitness is just as important for people with multiple sclerosis (MS) as for healthy people. Those with MS are currently recommended physical activity as there is strong evidence that it improves muscle function, aerobic fitness and mobility. There is also evidence that physical activity improves the overall quality of life. However, people with MS often have a reduced physical capacity. There are many reasons for this. It is not uncommon for those with MS to limit their physical activity so as to minimise the feeling of tiredness and avoid an elevated body temperature. More often than not, this complies with the advice of healthcare and medical professionals who feel that the patient should save his/her energy for daily chores. However, limited physical activity will lead to further weakness, fatigue and other health risks plus fewer chances of enjoying a leisure time hobby.

Daily activities, walks and water exercises combined with periods of rest/recovery are recommended. Participation in physical activities should be encouraged at home, at work or at a fitness centre. Those with MS should be well informed about potential symptoms that may arise from or increase as a result of physical activity such as fatigue, onsets due to heat intolerance and spasticity, and how such symptoms should be handled. Appropriate activities to be carried out at home as recommended by a physiotherapist or at a physiotherapy clinic should incorporate aerobic fitness and strength training, walking and water exercises. Training should take place at intervals and in a cool environment. There is strong evidence today that periods of intensive rehabilitation at a rehabilitation centre improve the level of activity and participation for those with MS.

In case of warm outdoor or indoor temperatures (for example in the gym), those with MS who suffer from heat intolerance may take a cool shower before and after training or use a cooling suit. Exercise done in connection with a pseudofit should be carefully monitored until all symptoms are stabilised. The same applies to infections such as urinary tract infections as well as cortisone medication.

Definition

Prevalence/Incidence

One in 800 people are diagnosed with MS. That is 11,000–12,000 people in Sweden and around half as many in Norway. Each year, 5 out of 100,000 people in Sweden get MS, i.e. around 450 people. Most of these are diagnosed with MS between the ages of 20 and 40 years old. MS is a chronic, lifelong illness with a variable development that often leads to significant disability.

Causes and risk factors

What causes MS is not known. Hereditary factors play a part in some cases, i.e. children of MS patients have a 2–4 per cent risk of developing the same illness. However, environmental factors are also likely to be of some significance although this has not yet been proven.

The prevailing theory is that MS is caused by an autoimmune reaction, in other words that the immune system incorrectly attacks the myelin of the central nervous system, i.e. the fatty insulating sheath that facilitates neural impulse transmissions. Consequently, the myelin producing cells or oligodendrocytes are damaged and reduced in number. The nervous system has a certain ability to heal, but the damage to the myelin and nerve fibres in the early stages of the illness is permanent.

Symptoms

The symptoms of MS vary greatly from person to person and over time. The early stages of MS are characterised by symptoms of onsets plus periodic symptoms caused by the effects on the central nervous system, such as sensory disorders, transient visual problems (optical nerve inflammation), balance disturbances, weakness (pareses) or problems with urination. In the later stages of the illness, the symptoms are usually more gradual and permanent, such as weakness in the legs leading to problems walking or with balance.

A small number of those with MS never experience any significant problems, but the majority will sooner or later develop various degrees of disability. From a random selection of individuals with MS, one out of ten had a normal walking speed. One in three people is self-reliant and has a normal social life. All areas of health-related quality of life are subjected to a strong negative impact, especially when it comes to walking, domestic chores, recreational and leisure activities, and one in five suffers from depression (1–4). After 15 years, one out of two people with MS will require a walking aid to walk 100 meters and after 25 years, one out of two will be confined to a wheelchair. After a period of 30 years, at least one in three people with MS needs help getting out of bed. MS shortens average life expectancy by 5–10 years.

Diagnostics

A diagnosis is always based on at least two separate symptoms, depending on which parts of the central nervous system that are affected. A brain scan using Magnetic Resonance Imaging (MRI) and a cerebrospinal fluid analysis are of major assistance when determining the diagnosis, especially in the early stages before the symptoms are completely clear.

Treatment

A so-called modification treatment has been available since the middle of the 1990s, initially using interferon-beta and in recent years glatiramer acetate as well, with the addition of natalizumab in 2006. These treatments reduce the frequency and severity of onsets and also slow down the development of other symptoms. However, the treatments are only partially effective and the long-term effect on the development of symptoms is not fully known. In addition, the possibility of alleviating different symptoms such as stiffness, pain, depression, fatigue and urination problems continues to improve. Recurrent rehabilitation periods incorporating physical exercise and identifying the needs for assistance also mean that disability can be reduced.

Effects of physical activity

MS is often associated with increased tiredness and heat intolerance, i.e. an exacerbation of symptoms as a result of an elevated body temperature. Even persons with a slight to moderate neurological deterioration may be severely hindered in life due to acute fatigue or pain.

Maintaining muscle activity, strength and aerobic fitness is just as important for people with MS as it is for people without MS (5). In recent years, scientific publications of rehabilitation (6–14) and exercise studies (15–25) have shown the benefits of regular physical activity. Those with MS are recommended physical activity as there is strong evidence that this improves muscle function, aerobic fitness and mobility (26). Moreover, physical activity has been shown to improve the quality of life for people with MS (27). There is evidence that exercise, regardless of whether it is similar to exercise for healthy individuals or is modified to maintain function, is of great benefit to those with MS and is therefore widely recommended. It is also recommended that exercise and rehabilitation be adapted to the individual needs and requirements of the person with MS, as no specific form or method of exercise has shown to be more effective than any other (26, 28). Rampello and colleagues (29) compared neurological rehabilitation with aerobic exercise in connection with distance and walking speed, and subsequently concluded that aerobic exercise generated the greatest improvements.

There is still limited evidence as to the level of exercise required in order to improve muscle strength and aerobic fitness (15, 16, 28). With regard to aerobic training, White and Dressendorfer (30) make the following recommendations; 20–30 minutes or 2 x 10–15 minutes 2–3 times a week at an intensity of 65–75 per cent of the maximal heart rate and 50–70 per cent of VO_2 max. The training should be of a moderate intensity (Borg scale 11–14). The time it takes to recover after a training session indicates the level of training required.

Compared with people without MS or with another illness (31–33) and even compared with healthy, but inactive people (34), individuals with MS have been shown to have a lower level of physical activity. This can lead to reduced muscle mass, weakness and reduced endurance not directly caused by MS, but rather as a secondary effect of inactivity. Reduced physical activity may in turn lead to less social interaction, restricted leisure activities and depression, generally affecting the quality of life. Conversely, persons with MS can enhance their quality of life by becoming more physically active.

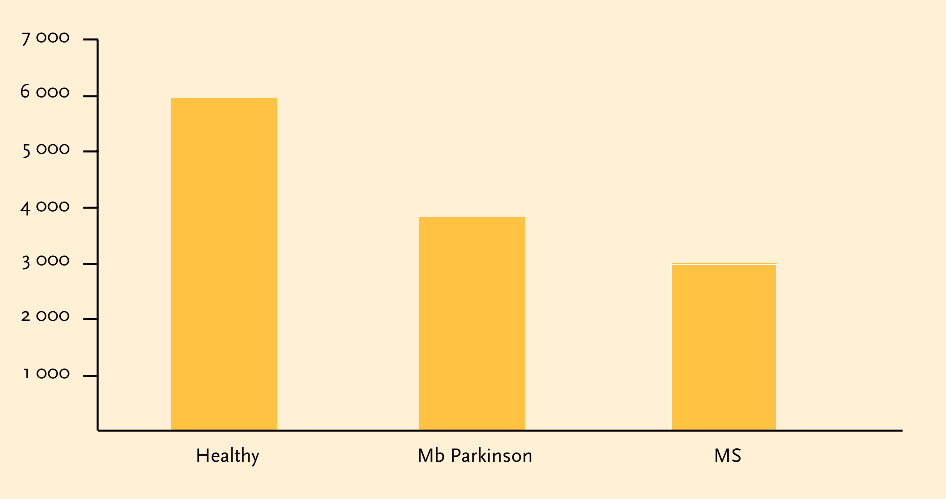

Figure 1. The average number of steps taken in a day for a period of seven days measured with a pedometer by people with Mb Parkinson, multiple sclerosis or in good health (33).

Physical activity and MS – specific aspects

The degree of physical activity should be adapted to the relevant circumstances. Special consideration must be given to people suffering from fatigue or heat intolerance. Physical exercise during a period of recurrent onsets can easily lead to increased symptoms in which case the exercise should be limited or avoided.

Of those with MS, 87 per cent experience severe fatigue. This is typical for the illness (35). The majority of people with a mild form of MS also experience severe fatigue (36). Patients often describe how they suffer from pronounced fatigue, muscular fatigue and the need for long periods of recovery following moderate muscular exertion. The increased level of muscular fatigue is not correlated with muscular weakness (37), although muscular strength is also affected following a short period of exertion (nerve fibre fatigue). This tiredness or fatigue affects all daily activities and the quality of life. Consequently, persons with MS need advice on how to manage the fatigue as it can easily lead to inactivity and further tiredness. Initially, persons with MS may need help to understand the concept of "MS fatigue" and how to best deal with this condition (38, 39). When informing a person with MS about fatigue, it helps to separate the condition into seven different forms of fatigue:

1. **Normal muscular fatigue** is to be expected after any physical/muscular exertion, but arises more rapidly for people with MS. A person with MS consumes more energy during a normal activity such as walking compared with a healthy person (40, 41). Therefore, it is important to find a balance between physical activity, recuperation/rest and daily events.
2. **Compensatory fatigue**. With MS, the stronger muscles compensate for the weaker muscles by taking more of the physical strain. This extra muscular work can lead to overexertion and tiredness. For example, the arm muscles of a person with MS have to cope with the added strain of pushing a wheelchair or supporting the body when walking with the help of crutches or a rollator.
3. **Fatigue due to depression** A loss of energy, desire and motivation is a manifest problem of depression. These feelings add to general physical tiredness, usually leading to reduced physical activity and increased fatigue (4, 26, 36, 42, 43).
4. **Cognitive fatigue**. Half of those with MS are cognitively affected (1). Tiredness may affect the cognitive function for persons with MS. This is often referred to as cognitive fatigue (44, 45). A short rest usually alleviates the problem.
5. **Cardiovascular fatigue**. Reduced fitness owing to inactivity leads to tiredness/reduced endurance. Swimming, water exercises, cycling, exercise bike training and walks will boost endurance and reduce tiredness (15, 18, 21, 22).
6. **MS related muscular fatigue** (46, 47). Individuals with MS require a longer period of recovery following exertion (47). Consequently, it is important to know one's personal limits. A physical activity should not exhaust the person in question. Sub-maximum effort is recommended. Persons with MS must allow themselves short breaks to gain new strength. A nap in the middle of the day may sometimes be necessary. For a person with MS to be able to continue working, it may even be necessary to reduce the number of working hours to allow time for physical activity and exercise.
7. **General fatigue with or without drowsiness**. Individuals with MS often have an increased need for sleep and may feel extremely tired despite having had a good night's sleep. In addition, those with MS often describe a feeling of mental and physical fatigue that is quite different from normal drowsiness.

Naturally, these different forms of fatigue require different types of treatment. However, graded exercise is generally thought to lessen the symptoms of MS fatigue (45). Recently, it has also been shown that rehabilitation at a rehabilitation centre can reduce the fatigue experienced by individuals with MS, a finding based on the improved disposition of the people monitored (48).

Table 1. Model for treatment of MS fatigue (49).

Physiology	Medication
Education	Better understand of symptoms
Adaptation	Planned activity/rest
Compensation	Use of aids
Physical activity	Individual/group

Many persons with MS are sensitive to heat. An increase in body temperature of just 0.1° C reduces the speed of nerve transmission, particularly where myelinated nerve fibres are damaged. As a result, previous or existing symptoms are augmented until the body temperature returns to normal.

An inability to endure physical activity and increased functional failure secondary to the increase in body temperature often occur (50–52), which is why a cool down in the form of a cool shower or a cooling suit may be necessary for any physical activity to be carried out (53–60). The cooling suit has been shown to be of benefit to persons with MS who are heat sensitive and is useful to facilitate an active life (60). Air conditioning, cool premises and a peaked cap (in sunshine) may also help.

Until now, the information available on physical exercise and strength training for patients with mild to moderate MS symptoms has been very limited (15, 16). However, recent findings confirm that physical exercise should be recommended to and is safe for persons with mild to moderate MS symptoms (25). Clinical experiences have shown that many people with mild MS symptoms are able to exercise to the same extent as healthy people and will benefit from using their muscles and increasing their level of fitness .

However, a large number of people with MS are worried that physical exercise may aggravate their illness and claims of such an association have been published in literature aimed at those with MS. Such claims have been put forward by alternative medicine practitioners despite the absence of any scientific evidence to support this hypothesis. Consequently, it is very important that people with MS learn how to handle the symptoms that may materialize in connection with physical activity so as not to be afraid of exercising or leading an active life (61, 62).

Physical activity/physiotherapy should be avoided while the patient is undergoing cortisone treatment, but can usually continue despite onsets as it minimises any loss of aerobic fitness and muscle strength. During the initial stages of an onset until a plateau is reached, flexibility exercise is recommended. Sometimes an exercise programme needs to be modified as a result of an onset and if necessary, incorporate additional aids. It is important to encourage, support and motivate a patient to resume physical activity following an onset although at a lower level of intensity. A new onset also often leads to a certain amount of depression and support is therefore vital.

Acute effects

Four weeks of cycling increased aerobic fitness by 13 per cent, overall work capacity by 11 per cent and the level of physical activity for the people monitored (22). Ten weeks of endurance training including cycling with an ergometer resulted in improved aerobic fitness and strength, reduced fatigue and enhanced quality of life (15). Another study showed that endurance training for a period of 4–6 weeks resulted in reduced fatigue and an enhanced feeling of well-being for people with MS (16). Water exercises increase muscle strength and endurance (18). Swimming has been shown to improve aerobic fitness and muscle strength. White and Dressendorfer (30) recommend training in water at a temperature of 27–29° C, but clinical experiences have shown that MS patients can cope with considerably warmer water (up to 34° C). The same authors (30) claim that progressive resistance training increases muscle strength while improving the chances of an active daily life (ADL) as well as psychosocial well-being. Regular aerobic training has an anti-depressive effect on the mild to moderate clinical depression found among many MS patients (30).

Two months of walking reduced limitations to activity and disability (20). Today, persons with MS are recommended to undergo more intensive rehabilitation at rehabilitation centres as there is strong evidence to suggest that this will quickly improve the level of activity and participation. There is also evidence to suggest that physical activity improves muscle function, aerobic fitness and mobility (26, 28).

Long-term effects

Water exercises increased the quality of life and made it easier for persons with MS to cope with daily household chores (increased functional capacity). The reduction in activity limitations and disability achieved after 6 weeks of rehabilitation remained for a period of 6 months while the health-related quality of life was enhanced for nearly 12 months (12). A different study indicated similar effects lasting for a period of 4 months (17). However, there is now strong new evidence suggesting that a less intensive rehabilitation over a longer period of time also improves the quality of life (28).

When comparing a group of active women with MS with a group of inactive women with MS, the active women had a lower risk of myocardial infarction (63). The increased risk of osteoporosis among women with MS could potentially be reduced by an increased level of activity (64).

Physical activity cannot the reduce the risk of an onset or stop the progress of the disease. However, physical activity that takes into account fatigue problems and heat sensitivity will help strengthen bodily functions and parts of the body that are either unaffected or only partly affected by MS. Avoiding physical activity only leads to worse aerobic fitness, less energy, lower motivation and flexibility, which in turn leads to a reduction in muscle strength. Weight gain caused by inactivity may have an adverse effect on mobility and lead to increased dependency.

Indications

Prevention

There is currently little information on prevention for persons with MS. As in the healthy population, physical activity is likely to:

1. Prevent problems, such as weakness and reduced endurance owing to inactivity.
2. Help improve general well-being and aerobic fitness (heart/lungs).
3. Help maintain good health and provide increased resistance to disease.
4. Stimulate motivation.

Increased physical activity for persons with MS who are not currently as active as the population at large (33, 34) is also likely to reduce the risk of cardiovascular disease and depression. Women with MS have a higher risk of getting osteoporosis, which in turn increases the risk of fractures. Physical activity may contribute to lowering this risk.

Prescription

Type of activity

There is currently no evidence available to determine the training dose (intensity, duration and frequency) for persons with MS. No training method has proven to be more effective than the other. However, there is strong evidence that physical exercise does affect persons with MS, regardless of whether it is similar to that recommended for healthy individuals or comprises exercises adapted to maintain function. Consequently, it is recommended that the training/rehabilitation be adapted to the individual, based on the needs of the person with MS (26, 28). Petjan and White have developed a Physical Activity and Exercise Pyramid for persons with MS (65).

Table 2. Exercise model for the improvement of muscular strength, endurance and physical activity for persons in different stages of MS (65).

	Muscular strength and endurance	**Physical activity**
No dysfunction, no problems with fatigue and/or heat sensitivity	*Modified strength training programme* • Large muscle groups can be subjected to 3 sets of 10–12 repetitive tasks. • The person training should not feel completely exhausted at the end of the third set of exercises. • The aim is for the extra strength to result in an improved balance and added motion that would otherwise have been avoided.	*Structured fitness training programme* Persons with no dysfunctions may exercise in the same way as a healthy person, but should perhaps cool down before training.
No dysfunction, but problems with fatigue and/or heat sensitivity	*Specific muscle strength training* • Strength training programme that takes into account strength, fatigue, motivation and degree of dysfunction. • Programme designed for balance and coordination training in supplement to the above. • Could the programme be adapted to home environment? • Water exercise.	*Active recreation* • Regular low-intensity training of less than 30 min./day, e.g. walking, cycling or gardening. • Aerobic training 3 times/week, 65% of VO_2 max for 20–30 min. • Body weight unloading training, e.g. cycling or water exercise.
Minor to moderate dysfunction	*Active and unloaded active motion* • A weak muscular system may be subjected to actively unloaded muscle training. • No studies with a clear guideline on frequency, degree of loading, etc. have been published to date.	*"Built-in inefficiencies"* • Individuals at this level are active, but balance all activities owing to the energy cost, sometimes unconsciously. • Training may involve making persons aware of this compensation mechanism.
Severe dysfunction	*Passive range of motion* • Passive motion to prevent contractures and maintain mobility. • Passive motion is primarily for hip extension, knee flexion, hip abduction and dorsal extension of the ankle joint.	*Activities in daily life (ADL)* • For persons with severe dysfunctions, activities in daily life (ADL) provide sufficient training. • These persons usually need home caregivers or family members to help them with shopping, doing the laundry, etc.

Persons with MS often feel that they lack sufficient knowledge to carry out a physical activity in a correct and safe manner (32) and hence, a general exercise prescription is not recommended. Consequently, a personal exercise plan taking into account the symptoms and effects of physical activity would be preferred in conjunction with a prescription for a physical activity/training programme to underline the importance of exercise (45).

Persons with MS often have a reduced physical capacity and it is important that some form of physical and mental exercise takes place. The physical training should consist of general exercises including aerobic training (fitness), strength training (endurance) and mobility/flexibility training. Training should start with a warm up and finish with a cool-down plus stretching exercises.

Daily activities, walks and water exercises combined with periods of rest/recovery are recommended. Participation in physical activities should be encouraged and take place either at home, at work or at a fitness centre. Training carried out in the home environment (66) and adapted to the status of the patient is preferred to avoid subjecting the person with MS to tiring travel. It is important that the training be followed up, especially if carried out in the home environment. A person with MS should be well aware of the MS related symptoms that may arise from physical activity such as fatigue, pseudo onset owing to heat intolerance and spasticity and how to handle these in connection with physical activity. Appropriate activities to be carried out at home as recommended by a physiotherapist or at a physiotherapy clinic should incorporate aerobic fitness and strength training, walking and water exercises (25, 26, 66). Training should take place at intervals and in a cool environment. There is strong evidence today that periods of intensive rehabilitation at a rehabilitation centre improve the level of activity and participation for individuals with MS.

Special considerations

Training should be carried out with caution in connection with onset, significant heat intolerance or cortisone treatment. The ability to exercise may be restricted by the fatigue so typical to MS despite good retained strength (see above).

Functional tests/need for health check-ups

A functional test should always be carried out prior to physical training to determine the appropriate individual level of intensity. A functional test should also be carried out at the end of each training session for the purpose of assessing the effects of the training programme and planned prescriptions.

The following is a selection of assessment instruments and areas of use:

Motor assessment

Motor assessments may either be carried out using strength tests on a scale of 0–5 or the Amended Motor Club Assessment (AMCA) (61), the Rivermead Mobility Index (67–68) or Birgitta Lindmark's motor assessment of active range of motions of the upper and lower extremities, limb movement velocity, motion capacity and balance (1, 69).

Walk/balance/endurance

Assessed using for example the 25 Feet Timed Walk (25, 70), 10 Meters Walk (1, 71), Timed Up and Go Test (72, 73), Physiological Cost Index, PCI (74, 75), 6-minute Walk Test (76, 77), Berg Balance Scale (78, 79) or the 12-item MS Walking Scale (MSWS-12) (80–82).

Health-related quality of life

Assessed using for example the Sickness Impact Scale (SIP) (3, 83), 36-item Short Form Health Survey Questionnaire (SF-36) (84, 85), Multiple Sclerosis Impact Scale-29 (MSIS-29) (86) or the Multiple Sclerosis Quality of Life-54 (MSQO-54) (87).

Fatigue

Assessed using for example the Fatigue Severity Scale (88), Fatigue Impact Scale (89) or the Fatigue Descriptive Scale (90).

Activity and participation

Assessed using for example the Guy's Neurological Disability Scale (GNDS) (91), Frenchay Social Activity Index (FAI) (2, 92) or the Barthel Index (BI) (93).

Interactions with drug therapy

Cortisone treatment is sometimes prescribed temporarily to inhibit onset. However, cortisone can lead to an increased risk of damage to bones, muscles and tendons.

A potential side effect of treatment with *interferon beta* is a slightly elevated body temperature. As a result, symptoms of heat intolerance may be aggravated and the ability to exercise restricted. However, this is normally a transient side-effect of treatment with interferon beta.

Contraindications

Exhaustive training should be avoided while submaximal training with a period of rest is recommended. Exercise done in connection with an onset should be carefully monitored until all symptoms have stabilised (26). This also applies to infections such as urinary infection and cortisone treatments.

Risks

Symptoms arising from exercise due to heat intolerance can in rare cases become permanent or only pass after a long period of time. Consequently, patients with pronounced heat intolerance should exercise with caution.

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