

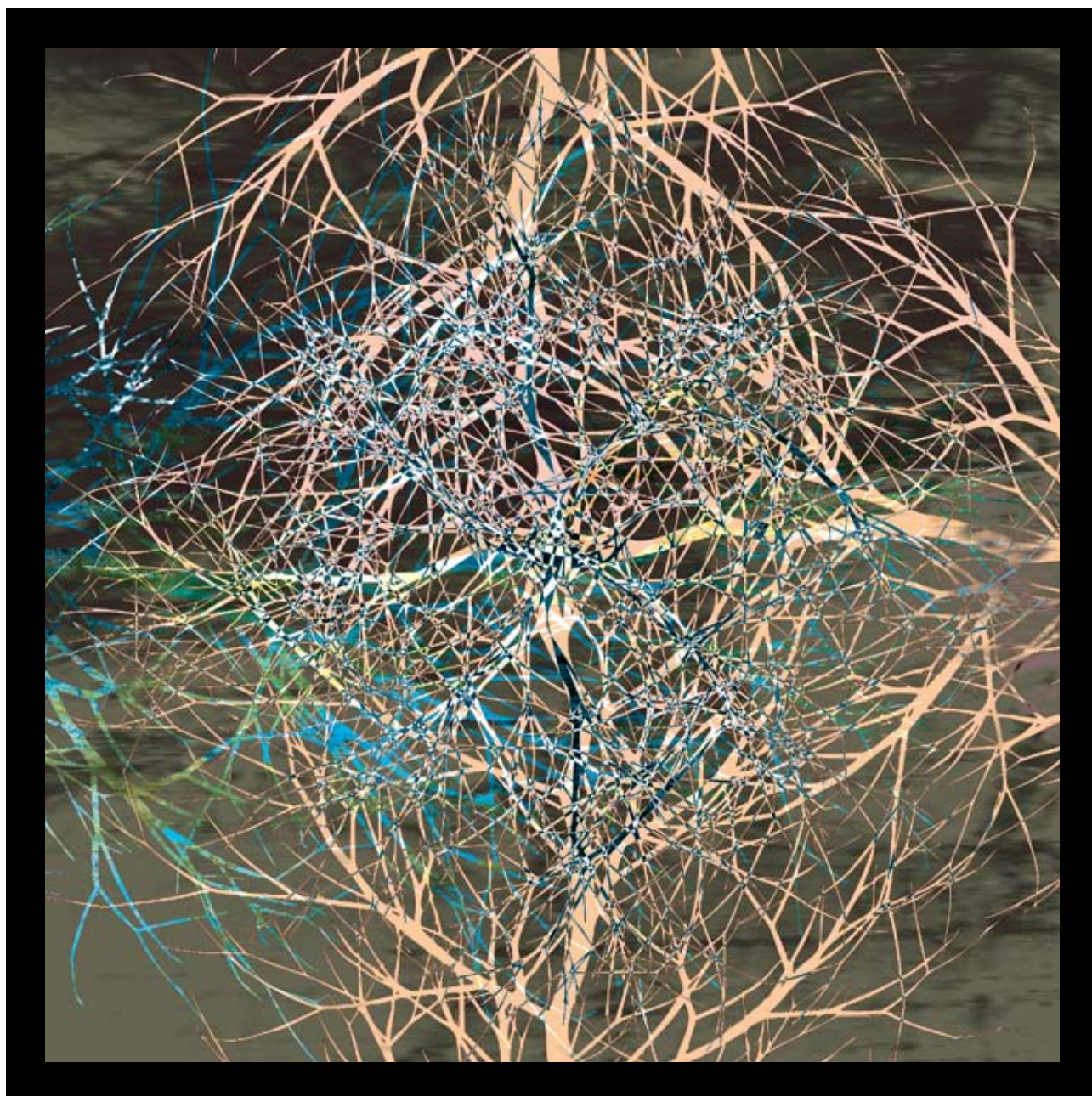


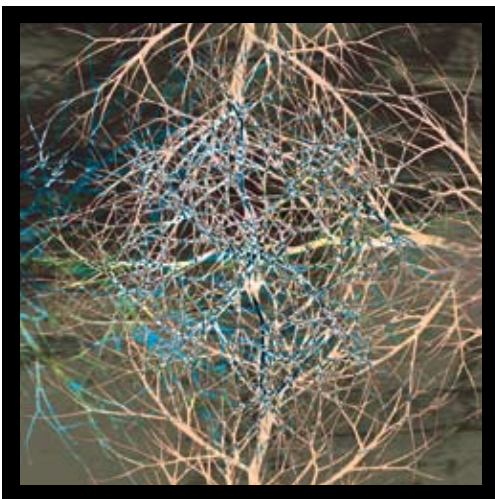
AUSTRALIA

FOR HEALTH PROFESSIONALS

PRACTICE

Strength and cardiorespiratory exercise
for people with multiple sclerosis (MS)





Strength and cardiorespiratory exercise for people with multiple sclerosis (MS)

People with MS experience specific problems that may affect their performance of strength and cardiorespiratory exercises. An understanding of the MS population is required for the successful implementation of such exercises.

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1.0 Rationale for exercise in MS

To date, there is no intervention that has been proven effective in modifying the long term prognosis in MS; however exercise is now accepted as an important part of symptomatic treatment for people with MS.¹

Until about twenty years ago people with MS were commonly advised to avoid strenuous physical activities or exercises on the basis that they might worsen the signs and symptoms of MS – even increase the disease activity. However, since then a growing body of evidence has indicated that exercise can be of benefit to people with MS, not only at the impairment level, but also at a functional and participation level.

There are many forms of exercise that people with MS can undertake, such as aquatic exercise, stretching, balance exercise, tai chi, yoga, and pilates; this handout will focus on strength and cardiorespiratory exercises.

Strength (or resistance) training and cardiorespiratory (or endurance) training are two basic physical exercises widely used in neurological rehabilitation. The successful implementation of these exercises requires physiotherapists to have a thorough understanding of the characteristics of the neurological populations that they are working with.

Strength and cardiorespiratory exercises are often prescribed for people with MS who have difficulties performing the activities of daily living and/or participating in leisure activities. These difficulties have been shown, in part, to be due to the primary effects of MS – such as loss of muscle activation and muscle control, fatigue, and spasticity – and in part due to the secondary effects – such as prolonged disuse, which results in deconditioning of the muscles, and reduced fitness.

This handout aims to provide basic knowledge about the specific problems experienced by people with MS and how they may affect their performance of strength and cardiorespiratory exercises. It also provides recommendations on the prescription of these types of exercises.

...exercise is now accepted as an important part of symptomatic treatment for people with MS.¹

2.0 Loss of muscle activation and fatigue

Slowed nerve conduction velocity is believed to be due to the plaques (or sclerosis) in the central nervous system (CNS). It is a result of demyelination and attempted remyelination by the body. As the disease progresses, it is believed the loss of axons and gray matter over time contribute to nerve conduction block and the presence of MS symptoms.² These nerve conduction abnormalities result in:

- Impaired central activation³
- Reduced motor unit recruitment and discharge rates^{3,4}
- Reduced cortical drive⁵
- Increased cortical activation per activity compared with people without MS.⁶

Symptomatically, these changes present as a reduction in force production by the muscles (weakness) and rapid decline in force production (fatigue).

3.0 Secondary disuse

People with MS who suffer from loss of muscle activation and control often experience difficulty participating in both activities of daily living and leisure activities.^{7,8} This can lead to a gradual decrease in physical activity. It has been shown that in people with MS, physical limitations are positively correlated with physiological changes. These limitations have been shown to be similar to those that occur in healthy people who have experienced prolonged physical inactivity.

Examples of such changes include:

- Reduced muscle force as a consequence of:
 - Changes in metabolic levels⁹⁻¹¹
 - Failure of the excitation–contraction coupling mechanism¹¹
 - Reduced muscle fibre size and number.^{12,13}
- Reduced cardiorespiratory fitness as a consequence of:
 - Lower VO₂ maximum (maximum capacity to transport and utilise oxygen during exercise)¹³
 - Higher overall oxygen consumption per activity
 - Earlier achievement of the anaerobic threshold.¹⁴

It is important to note that in people with MS, respiratory muscle strength may also be impaired due to either the disease process or disuse influences. The weakness in respiratory muscles is correlated with higher levels of inactivity and disability.^{15,16} A study involving severely disabled people with MS reported that respiratory muscle weakness correlated with significant reduction in quality of life and exercise participation (as a consequence of a reduced forced vital capacity, inspiratory and expiratory maximal pressures and secretion clearance).¹⁷

The weakness in respiratory muscles is correlated with higher levels of inactivity and disability.^{15,16}

4.0 Starting regular exercise soon after diagnosis

Traditionally, people with MS have sought advice on exercise or rehabilitation once they have developed functional movement difficulties. However, recent evidence highlights the benefits of exercise as an early intervention, even before clinical symptoms of MS are observed. It has been shown that people with a recent diagnosis of MS, who have no observable physical disability (Expanded Disability Status Scale [EDSS] score of between 0–2) already have kinematic, kinetic, balance, and muscle activation changes.^{18,19} This sub-group of people are the most likely to experience brain adaptations as neuroplasticity and increased central activation is more effective in people with fewer lesions.²⁰ Furthermore, higher exercise levels have been shown to relate to slower accumulation of functional limitations, and improved quality of life over time in people with MS.⁸

It is important to encourage people with MS to start a regular exercise program early in the disease course. Targeting identified deficits can maximise their physical abilities through neuroplastic adaptations

and prevention of the secondary effects of inactivity. This can in turn improve quality of life by reducing levels of physical disability, improving employment sustainability, and reducing the utilisation of welfare benefits and health services.²¹

Researchers are now investigating a possible link between exercise and immunological function in people with MS. Further research into this area may provide additional support for adherence to a regular strength or cardiorespiratory exercise program early after the diagnosis of MS, or as a preventative measure.

5.0 Strength training

Considerable historical debate exists regarding the safety and appropriateness of prescribing strenuous physical activity for people with MS. Concern has focused on the possibility of exacerbating MS symptoms, such as fatigue,^{22,23} or weakness,²² which could be counterproductive to day-to-day symptom management. However, there is now strong evidence indicating that exercise does not cause prolonged or permanent worsening of MS symptoms.²⁴ On the contrary, exercise can often result in improvements in a range of MS symptoms,^{1,25} and no adverse effects of strength exercise in the MS population have been documented in the literature.

5.1 The benefits of strength training

The highest level of evidence for the benefits of strength training in people with MS shows that strength training can improve muscle force production.²⁶

Lower levels of evidence show the following benefits:

- Improved walking speed and endurance^{27,28}
- Improved self efficacy²⁸
- Improved gait kinematics²⁹
- Improved immune system function³⁰
- Improved respiratory muscle strength^{17,31}
- Reduced fatigue^{28,32}
- Reduced physical and social disability²⁸
- Reduced symptoms of coronary artery disease.³²

Some people with MS have reported that exercise preceded an MS exacerbation, but no studies have been able to identify exercise as the cause of exacerbations. It should be noted that exercise can result in a temporary increase in existing symptoms or onset of new previously silent symptoms in people with MS.²⁴ This is probably related to a heat-induced reduction in nerve conduction velocity. Such symptoms tend to resolve within thirty minutes of rest.²⁴

5.2 Strength training methods

Strength training methods used in research are:

- Progressive resistance exercises using body weight and weighted vests²⁶
- Progressive resistance exercises using machines^{27,28}
- High repetition, low load exercises using machines or free-weights.³³

Strength training using functional weight bearing positions may provide greater improvements in functional measures than free-weights.²⁶ It is important to use positions and equipment that are accessible and safe, and to consider an individual's mobility, balance, cognitive status, co-morbidities and any other existing MS symptoms. Thus, free-weights and resistance machines may be useful when functional training is not possible and when the person has significant focal weakness.

5.3 Strength training dose

The training doses used in research vary significantly. The most commonly used strength training doses are detailed in table 1.

Table 1. Common strength training doses for people with MS

Weight	Most studies recommend loads of 60–80% of the one repetition maximum (RM)
Repetitions	8–15
Sets	1–3
Sessions	Range from 3–5 per week, however guidelines recommend 2–3 sessions per week
Progression	Increase weight by 2–5% when able to complete 12–15 repetitions without loss of form over two training sessions.

Studies that showed the greatest increases in strength prescribed heavier weights, i.e., using the higher end of the 60–80% of the 1 RM (approximately 12 RM), and at least two sets.²⁸ Some studies suggested allowing full recovery between training sessions,³⁴ and alternating between strength and cardiorespiratory training on separate days, with one-to-two days rest between each session.³⁵ According to this guideline, two-to-three sessions of strength training per week is recommended.

It is important to note that people with MS who experience symptomatic fatigue or irritable symptom aggravation will require a flexible approach to weight training and progression. For example, to manage fatigue or avoid heat induced symptoms, alternate between upper and lower limb exercises, exercise when it is cooler, perform exercise earlier in the day to avoid tiredness, or undertake short sessions of exercise throughout the day.

5.4 Strength testing

The American College of Sports Medicine (ACSM) provides the following guidelines for strength assessment of people with chronic conditions:³⁵

- Test targeted muscle groups that have been identified during functional assessments
- Use standardised testing equipment so that measures are repeatable
- Use the 12 RM in preference to the 1RM during testing.

6.0 Cardiorespiratory training

A large body of research has investigated the benefits of cardiorespiratory (or endurance) exercise in people with MS. In a recent review by Dalgas *et al.*³⁶ at least 14 studies were identified that evaluated the effects of endurance training in people with MS. Although there are general methodological weaknesses in these studies, several important clinical findings can be derived from the results. Endurance exercise at low-to-moderate intensity is well tolerated and has potential effects on both physiology and psychology among people with MS.³⁶ However these studies have primarily involved subjects who are minimally-to-moderately physically disabled and have an EDSS score of less than 7. Only one case study investigated the response to arm-crank aerobic training in a wheelchair using a participant with an EDSS of 7.5.³⁷

6.1 Cardiorespiratory risk factors

Concerns have been raised regarding cardiorespiratory testing and fitness training in older and long-term sedentary people – especially those with a number of other risk factors. In recognition of these concerns the ACSM recommends allocating exercise participants into one of two streams for cardiorespiratory testing and exercise prescription, as specified below.³⁵

- **High risk** – Individuals with more than two risk factors for cardiorespiratory disease need formal testing to ascertain actual working heart rate to achieve VO₂ maximum. This eliminates the safety issues relating to blunted heart rate response, poor systolic elevation and cardiac risk factors. Exercise prescription is based on the measures obtained through this testing. Details on formal cardiorespiratory testing are provided in section 6.5 of this handout.

- **Low-to-moderate risk** – Individuals with two or less risk factors for cardiorespiratory disease can be prescribed exercises using heart rate and supplementary exercise intensity measures. These include the Borg Rate of Perceived Exertion (RPE) scale and blood pressure monitoring.

Table 2 outlines risk levels and risk factors for cardiorespiratory disease.

Endurance exercise at low-to-moderate intensity is well tolerated and has potential effects on both physiology and psychology among people with MS.³⁶

Table 2. Cardiorespiratory risk category checklist

Risk level	Risk factor	Risk level	Risk factor
Low	<ul style="list-style-type: none"> Younger individuals (men <45 years, women <55 years) No symptoms for cardiac issues Meet no more than one risk factor threshold from the 'Signs and symptoms of cardiorespiratory and pulmonary disease checklist'. 	High	<ul style="list-style-type: none"> Individuals with one or more signs and symptoms from the 'Signs and symptoms of cardiorespiratory and pulmonary disease checklist', and a known cardiorespiratory, pulmonary, or metabolic disease. <p>Cardiorespiratory disease includes:</p> <ul style="list-style-type: none"> Cardiac peripheral vascular disease Cerebrovascular disease <p>Pulmonary disease includes:</p> <ul style="list-style-type: none"> Chronic obstructive pulmonary disease Asthma Interstitial lung disease Cystic fibrosis. <p>Metabolic disease includes:</p> <ul style="list-style-type: none"> Diabetes mellitus 1 and 2 Thyroid disorders Renal or liver disease.
Moderate	<ul style="list-style-type: none"> Older individuals (men ≥45 years, women ≥55 years) Those who meet the threshold for two or more risk factors from the 'Signs and symptoms of cardiorespiratory and pulmonary disease checklist'. 		

Signs and symptoms of cardiorespiratory and pulmonary disease:

- Pain, discomfort (or other anginal equivalent) in the chest, neck, jaw, arms, or other areas that may be due to ischemia
- Shortness of breath at rest or with mild exertion
- Dizziness or syncope
- Orthopnea or paroxysmal nocturnal dyspnea
- Ankle oedema
- Palpitations or tachycardia
- Intermittent claudication
- Known heart murmur
- Unusual fatigue or shortness of breath with usual activities.

It is recommended that clinicians adopt these guidelines when testing and prescribing exercise for people with MS who are inactive. Individuals considered to be at high risk should obtain medical clearance from their treating doctor(s) before commencing any exercise programs, and should start at low intensity.

6.2 Cardiorespiratory training benefits

Many benefits of cardiorespiratory training have been identified in people with MS. The following list includes two level II studies by Petajan *et al.*³⁸ and Mostert and Kesselring.³⁹ The other studies are above level IV research quality.

The identified benefits include:

- Improved maximum or peak oxygen uptake (VO₂ peak)^{38,40-42}
- Improved muscle strength in the muscles that were working during the exercise protocol³⁸
- Improved lung function⁴¹
- Improved activity levels³⁹
- Improved aerobic thresholds³⁹
- Improved work capacity as measured by oxygen utilisation³⁸
- Improved mood state and quality of life^{38,39,43}
- Improved functional capacity and gait^{42,43}
- Delayed onset or reduction of fatigue.^{38,39,41,44}

To date, no studies have reported adverse cardiac symptoms in response to cardiorespiratory testing or exercise participation in people with MS. This may be due to the testing of individuals who are predominantly minimally-to-moderately disabled (EDSS 0–6). It may also be that most studies commenced cardiorespiratory training within the 50–60% of maximal predicted heart rate range, with gradual increases in intensity over the training period.

There are certain symptoms that may impede people with MS when undertaking cardiorespiratory exercise, such as fatigue, heat intolerance and spasticity. These symptoms can be managed to a certain extent for optimal patient compliance and adherence to exercise. For detailed strategies refer to the *Complex symptoms of multiple sclerosis* and *Spasticity and multiple sclerosis handouts*.

6.3 Cardiorespiratory training methods

Common training methods adopted in research protocols include:

- Recumbent or upright cycling^{30,38,39}
- Treadmill^{45,46}
- Aquatic aerobic exercise (small case study reports level IV)^{47,48}
- Arm-crank for wheelchair users (case study report level IV).³⁷

It is important to use equipment that is safe for the individual (based on their range of symptoms and comorbidities) and to take steps to prevent musculoskeletal injuries. People in the later stages of MS are often wheelchair-bound and may have difficulties in using these training modes (e.g., due to poor balanced sitting or transferring issues). The new version of the MotorMed exercise machine (a machine that has exercise cranks for upper body exercise, lower limb pedals that can be used as a stationary bicycle, and provides advanced feedback on patient activity) may be a useful piece of equipment for such people. However, no studies have formally investigated the benefits of this machine in advanced cases of MS.

6.4 Cardiorespiratory training dose

The most commonly used cardiorespiratory training doses adopted in research protocols are shown in table 3.

Starting an exercise program at a lower intensity, such as 50–60% of PHRmax, exercising for a shorter duration, or interval training may help prevent undue

fatigue and symptom aggravation (e.g., increased core temperature). Worsening symptoms or appearance of new sensory symptoms may occur during cardiorespiratory exercise; however these symptoms should resolve within 30 minutes of rest.²⁴ Training intensity or duration should be reduced if symptoms persist beyond this time.

6.5 Cardiorespiratory testing

As discussed, all people with MS should be screened for cardiorespiratory risk factors to establish their level of risk (see table 2) before prescribing exercise. Those who are deemed to be at high risk should undergo formal cardiorespiratory testing, in accordance with the the relevant guidelines.³⁵

Low-to-moderate risk –

- PHRmax is commonly calculated as 220 minus age (± 10) beats per minute. Note that using a PHRmax formula that includes resting heart rate (Karvonen Formula) produces a higher PHRmax than the basic formula shown above and is not recommended in this client group.
- Complete testing on a bicycle when there is concern about walking ability or safety (e.g., for clients who have ataxia or foot-drop).
- Monitor heart rate, blood pressure and RPE throughout testing, noting levels at each increment. Monitoring this combination of measures can assist the clinician to accurately identify response to exercise even if autonomic dysfunction is causing a blunted heart rate. For further information about autonomic dysfunction refer to the *Complex symptoms in multiple sclerosis* handout.
- Start at a slow pace for a two-minute warm-up and then increase the workload by 10–25 W at each exercise increment or stage. This is done by increasing revolutions per minute or resistance.

Table 3. Commonly used cardiorespiratory training doses for people with MS

Intensity	Target heart rate (THR) is 50–75% of maximal predicted heart rate (PHRmax), 50–75% VO ₂ peak or Rating of Perceived Exertion (RPE) of 11–14 (original Borg scale)
Duration	20–40 minutes or two shorter sessions of 10–20 minutes completed on the same day
Sessions	2–3 times per week
Progression	Intensity and effort increased gradually over time to maintain THR and/or RPE

Maintain exercise at each stage for 1–3 minutes and then continue to increase until THR is reached.

- Testing should cease if a person experiences symptoms that prevent them from exercising until they reach THR or if they become distressed.
- Once THR is reached, slowly reduce the work load over five minutes. Continue to monitor heart rate, blood pressure and RPE until their heart rate and blood pressure have returned to baseline.

- Take note of the exercise intensity at which THR was achieved.

High risk –

- Refer the person for formal graded exercise testing
- Base exercise intensity on the actual heart rate response to a graded exercise test rather than the estimated age-related maximal heart rate.

7.0 Summary

- In people with MS weakness, poor endurance and functional impairment can be a result of loss of muscle activation or muscle control. This is due to the disease process of MS and/or secondary effects from prolonged disuse.
- The secondary effects of disuse can be prevented or reversed in people with MS. The earlier the interventions the better.
- Exercise does not make MS worse, but may lead to a temporary worsening of existing symptoms or onset of new symptoms.

Strength training

- Progressive resistive strength training improves the strength of targeted muscles in people with MS.
- Allow full recovery between strength training sessions by alternating between strength and cardiorespiratory training on separate days – completing a maximum of two-to-three strength training sessions per week.
- People with MS who experience fatigue will require a flexible approach to weight progression in their strength training program.

Cardiorespiratory training

- Endurance exercise can significantly improve poor cardiorespiratory functions and many other symptoms reported by people with MS.
- People with MS who have greater than two risk factors for cardiorespiratory disease should undergo formal testing. This will establish their working heart rate to achieve the desired percentage VO₂ maximum.
- Starting an exercise program at a lower intensity, such as 50–60% THR or work load maximum, and exercising for shorter duration, may help to prevent undue fatigue and symptom aggravation.

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MS Practice//For Health Professionals

MS Practice is an initiative of MS Australia (MSA). MS Practice is an online resource designed to support allied health professionals in the symptom management of people with multiple sclerosis (MS). The series addresses the various symptoms associated with MS, providing health professionals with evidence-based information and clinical practice recommendations to enhance the quality of care and outcomes for people with MS. The MS Practice topics were identified by the MSA Physiotherapy Network.

Strength and cardiorespiratory exercise for people with multiple sclerosis

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Credits

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MS Australia

MS Australia is a not-for-profit organisation that has been supporting people with MS since 1956. Through state-based MS Societies, MS Australia strives for a world without MS through quality research and service excellence for people with multiple sclerosis, their family and friends, and healthcare professionals.

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Disclaimer

This handout is intended to provide information to support current best practice for the management and treatment of physical impairments in people with MS. While the information is available to all health professionals, there are details that are most relevant to physiotherapists, exercise physiologists, and people who are qualified to provide exercise opportunities for people with MS. MS Australia has made every effort to ensure that the information in this publication is correct. MSA does not accept legal responsibility or liability for any errors or omissions, or for any physical or financial loss incurred whilst participating in the exercises or activities outlined in the MS Practice handouts. Be sure to seek advice from the sources listed.



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